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ANCHOR FOR RAILWAY CARRIAGES ON INCLINED PLANES.

Fig. 1.

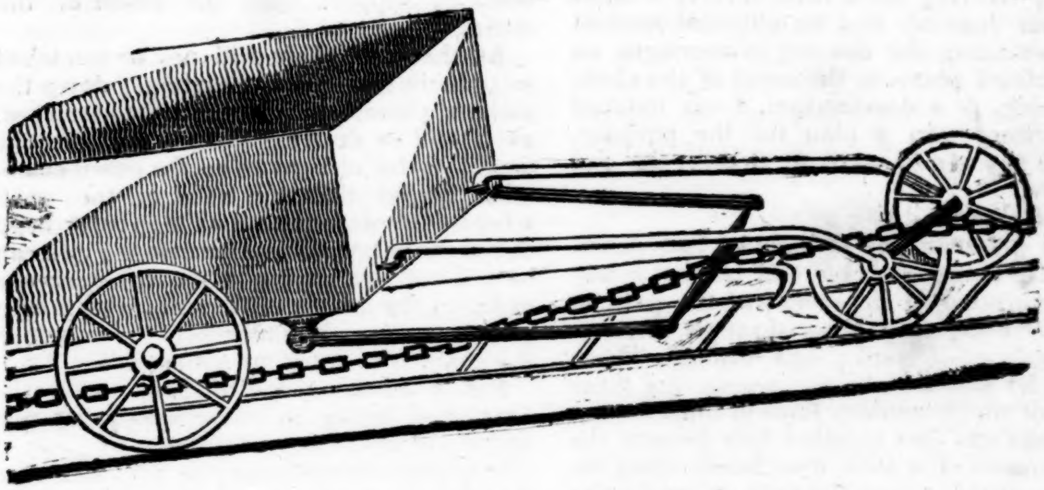


Fig. 2.

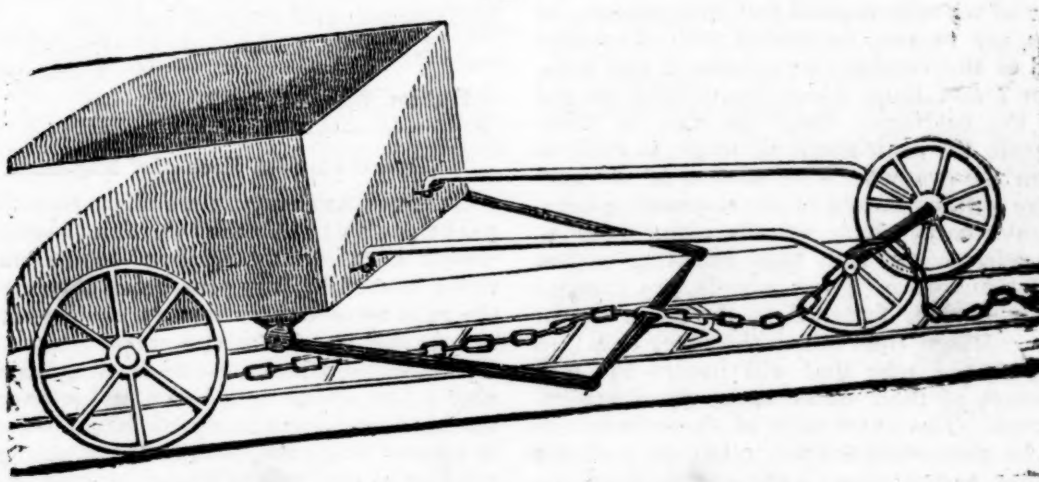


Fig. 4.

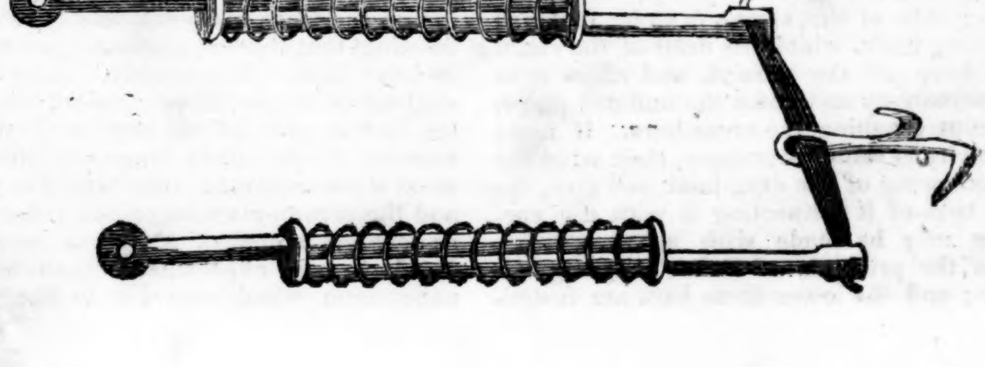
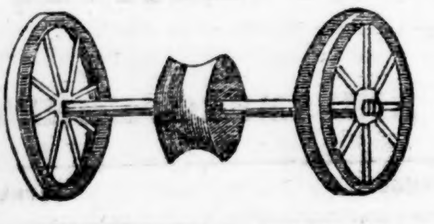


Fig. 3.



[From the London Mechanics' Magazine.]

ANCHOR FOR RAILWAY-CARRIAGES ON INCLINED PLANES.

Sir,—Having seen, from several articles in your Journal, that an effectual method of preventing the descent of carriages on an inclined plane, in the event of the chain breaking, is a desideratum, I am induced to forward you a plan for the purpose, which appears to me likely to meet the end in view.

The plan is as follows:

Let a double line of rails be laid down, about 18 inches asunder, and secured firmly in the ground in the middle of the path of the carriage, with holes through them at intervals of a yard; and through these holes let iron bars be put, connecting these new or supplementary lines of rails, so that the rails and bars together may present the appearance of a long iron ladder lying on the ground between the rails on which the carriage runs. Upon these rails a small pair of wheels, about 2 feet in diameter, or less, are to run, connected with the upper end of the carriage by means of two bars, 6 or 7 feet long, which are to hook on and off the carriage. Over the axle of these wheels the draft-chain is to go, to raise it from the ground. The motion of the carriage will, by means of the connecting-bars, always carry these wheels along with it. Another pair of iron bars, reaching within a few inches of these wheels, are then to be hooked or fastened to the same end of the carriage (but below the other bars), in any simple way that will insure the free descent of their outer ends when unsupported. The outer ends of these bars are to be connected to each other by a strong spring across them, sufficient to bear the sudden check in stopping the descent of the carriage; the draft-chain must go over and be hooked to this spring; and to the under side of the spring is to be fastened a strong hook, which the draft of the chain will keep off the ground, and allow it to pass freely up and down the inclined plane, without touching the cross-bars. If more elasticity is found necessary, than what the cross-spring of the drag-hook will give, the side bars of it connecting it with the carriage may be made with spiral springs, upon the principle of Salter's spring-balance; and the lower these bars are fastened on the carriage, the less quantity of upward pull there will be on the cross-bars and rails to disturb them in their bed.

Fig. 1 is a representation of a carriage, provided with such an appendage as I have described, in the act of ascending or descending an inclined plane. The draft-chain is on the stretch, and the drag-hook supported off the ground by the strain of the chain.

Fig. 2 shows the carriage with the draft-chain broken, and the hook anchored on one of the cross-bars, having fallen for want of support from the strain of the chain.

As the draft-chain will not be stretched so tight in transporting carriages down the inclined plane, or drawing empty carriages, as it will in drawing them up, it may be useful to be able to raise the chain somewhat higher than the axle of the small wheels, to compensate for the greater bend of the chain upon those occasions; this can be effected by having a moveable sheave to fix on the middle of the axle, with a deep groove on its circumference, over which the chain is to work, as shown in fig. 3.

Fig. 4 shows the draft-hook, with the drag-hook under it, the cross-spring and spiral-springs to the side-bars.

It is scarcely necessary to add, that after the carriages have been drawn up or let down the inclined plane, all the bars may be detached, and the rails left clear.

I am, sir, your obedient servant,

C. PUTLAND.

Dublin, Feb. 14, 1835.

[From the London Mechanics' Magazine.]

SAFETY APPENDAGE TO RAILWAY-CARRIAGES.—Sir: Of the various accidents which occasionally happen on railways, those caused by waggons being thrown off the rails by sticks or stones laying across or *on* the rails, are the most numerous. Being on the Stockton and Darlington railway a few weeks ago, I saw an instance of the kind, but fortunately no harm ensued. A train of waggons, heavily laden, was proceeding at the rate of about sixteen miles an hour, when one of the wheels of the foremost of the train came in contact with a piece of coal, which happened to be laying on the plate, and such was the force of meeting, that the waggon leapt two or three inches high. Fortunately, however, it alighted in its proper position on the rails; for, had it gone off the way, such was the velocity of the other waggons, that they must have been inevitably dashed to pieces, and the person attending them either killed or severely wounded. As it was, no further damage was experienced than a slight concussion, which was felt to the end of

the train; owing to the first waggon losing time by leaping, and the rest overtaking and striking against it. Being an eye-witness of this *almost* catastrophe, it naturally made me try to devise some plan to remedy the possibility of accident on that head, and the following was the result of my cogitations. On each side of the first waggon of the train, I would have a kind of shovel fixed, so hung as just to clear the rail, that it may cause no unnecessary friction. Now, were a stone, stick, or any thing else, laying on or across the way, it would be an utter impossibility for the waggon to run over it, as it would not come in contact with the wheel. The shovel would either throw it off the rails or push it forward. Even if a man should fall across the road, as sometimes happens, instead of having his legs cut off, he would be thrown on one side, and be but little if at all hurt. This shovel might be hung by an adjusting chain, and in cases of severe frost, or a slight fall of snow over-night, might be let down upon the rail, when it would prepare it for the progress of the vehicle.

I am, Sir, yours respectfully,

WM. PEARSON.

Bishop-Auckland, Nov. 4, 1834.

[Since the date of the preceding communication from Mr. Pearson, we have received another letter from him, in which he says: "About two days after I had sent you my proposed Safety Appendage for Railway-Carriages, an accident happened on the Stockton and Darlington railway, which I feel assured could *not* have happened had the plan there proposed been in use. The misfortune alluded to befel as follows: an engine, with a train of waggons, proceeding down the way at a rapid rate, came in contact with an old brake, which was laying across the rails, and by the concussion the engine was thrown off the road—the engine-man (James Cleasby) was killed, his brains being dashed out against the water-tank, and much damage was done besides. The proprietors of the railway were so convinced that the brake had been designedly laid across the way, that they offered a reward of twenty pounds on the conviction of the miscreant who did it; but, unhappily for the cause of justice and humanity, the 'foul deed' has not yet been brought to light. On hearing how the accident occurred, I felt convinced that the appendage I have proposed would have prevented it. It must either have pushed the brake before the engine, till the engineer became aware of the impediment, or have eventually shoved it off the road! The wheel *could not possibly* have come in contact with it, and therefore the engine *could not* have been thrown off the road!" Two plans for the prevention of such accidents, very similar to that of Mr. Pearson, were proposed by Sir George Cayley, Bart., and Mr. Suddington.—Ed. London Mechanics' Magazine.]

Visit to the Messrs. Reynolds' Establishment at Kinderhook, New-York.

To the Editor of the Mechanics' Magazine:

Sir,—As my entire mental constitution is so completely tuned, and adapted to mechanical operations, that I should almost take pleasure in being ground up in any establishment which consisted chiefly of machinery, you would naturally expect to find me visiting and reconnoitring and examining and philosophizing upon, in mass and in detail, every mechanical, and especially every machine using establishment, which comes in my way; or rather which I come in the way of, even if I have to go considerably out of my way to do it.

In one of these reconnoitring excursions, which I lately made to that part of the town of Kinderhook, distinguished in the Golden Knickerbocker day by the cognomen of Valatie, partly to examine the progress of mechanical improvements there and partly to visit my friends, the Reynoldses, of that place—for I scarcely need tell you that every man who excels in nice mechanical operations is my friend, or, at any rate, I am his—I saw some improvements which I think ought to be duly noticed in your useful Magazine.

But before going into the detail of of those improvements, I hope my said friends will pardon the liberty I take, in offering you some remarks on the persons by whom the improvements have been made. They are three brothers, who appear, at least to me, to possess in an uncommon share that kind of native intellect which, when properly cultivated, becomes what is commonly called mechanical ingenuity. They are yet in early life, and have served regular apprenticeships at those branches of business, which, when combined together, embrace all the operations of machine making. They are united together, not only by the strongest tie of consanguinity, but by a congeniality of mind rarely to be met with in three members of the same family. They have, from the earliest

periods of their apprenticeships, devoted their leisure hours industriously to the acquirement of such branches of science as might aid them in future business; and the joint result of their studies amounts, I should think, to a stock of mechanical science, perhaps not surpassed, if equalled, in any other establishment of the kind in this country. As their seasons for study must have been limited, it would seem they have so managed their subjects that, whenever one is at a loss, another is ready to prompt him. By the joint avails of their industry, previously to their uniting, they had acquired the pecuniary means of procuring an excellent water privilege, erecting shops, &c., to make a very respectable beginning. Every article in their shops exhibits a degree of skill in plan and arrangement, and of taste and neatness of workmanship, which are of the highest order. I am confident the most competent judge would, upon critical examination, pronounce their establishment an honor to themselves and the country.

But to return to the improvements.

The first which attracted my notice is a saw-mill, on a scale about half the size of the common saw-mill, but which may be as suitably applied to use on one scale as another. I think any person with a mechanical eye, who sees it, will concede that the propelling power necessary for a saw-mill of the common form and size, with one saw, would on this plan drive four of the same size. I will endeavor to give you a brief description, together with a diagram, which will, I think, make it clearly understood.

The saws are held and operated by two balance beams or walking beams, similar to those used in the common steam engine. These beams are placed horizontally one above the other, exactly parallel, and their distance from each other about twice the length of the saw, more or less. Each beam is supported in the middle by a strong fulcrum or axis, resting on its pivots or bearings; which pivots or bearings are supported in the following manner.

The bearings of the lower axis rest upon strong side timbers of an oblong frame, about half way from the bottom to top, which frame is to sustain on its top the carriage and log or other timber to be sawed, with the necessary apparatus and fixtures for fastening the log, and moving it forward against the saw.

The axis of the upper beam is supported in proper boxes in two hangers or timbers, projecting downward from the framework of the building above, and must of course be securely braced.

On each end of each of these beams is a segment of a circle, the radius of which is exactly half the length of the beams; and each segment will contain about 70 or 80 degrees of a circle, more or less. Each segment has a flat steel spring, about the length of the periphery of the segment, and as wide as the thickness of the same, and the thickness of the springs about one-third or one-half that of the saw. One end of each of these springs is attached to the outer end of one of the segments, that is, to the lower end of the lower segments and to the upper end of the upper segments. The faces of the segments being made smooth, the springs will, of course, when bent to them, lie flat.

It will be readily perceived, that if the inner or approximate ends of the springs at each end of each beam, that is, a top spring and a bottom spring at each end of the beams, were connected together, in any manner so as to draw them tight, and the beams were, at the same time, placed in a parallel and horizontal position, the string, or whatever connected the top and bottom beams, with their respective springs, together, would make part of a tangent line from the centre of one segment to the centre of the other. When the beams are thus placed, if the ends are moved alternately up and down, the lines of connection between the top and bottom beams and segments will move exactly up and down, without any lateral motion whatever. If, then, these two connecting lines consist of two saws, attached to the aforesaid springs, the saws will move up and down as accurately as if carried up and down with a saw-gate, and perhaps more so. And if the power of a crank motion be applied to the centre end of either of the segments, both saws will be put in operation, one going up as the other goes down, and *vice versa.*

These saws may stand with their teeth

in any direction, either to cut parallel with the beams or at right or any other angle. We have then two complete saw-mills, operated by the same power which would operate one; and a gang of any number of saws may be operated in the same manner. If, however, the saws are set so as to cut parallel with the beams, one saw will interfere with the other; it will be necessary therefore to have the saws cut at right angles with the beams, and then, of course, the two logs can move parallel with each other.

By this plan, the weight necessarily moved up and down with the saws will be but a small part of the weight of the common saw-gate, and one saw completely balances the other, so that the power of a child will give the saws the necessary motion, except the resistance produced by cutting.

As the moving the log and other subservient operations may be effected as in the common saw-mill, no description is therefore necessary. The diagram will show the mode of hanging and operating the saw, which forms the basis of the improvement.

Several other improvements found in the same establishment will be noticed hereafter. S. B.

We are very much obliged to "A Young Engineer" for the following communication, and hope to hear again from him.

To the Editor of the Mechanics' Magazine:

SIR,—Having been employed in November last to ascertain the number and capacity of the steam engines then in use in this city, for the various manufacturing purposes with which our city abounds, and thinking that an abstract would be interesting to many of your readers, I have prepared the following, namely:

Whole number of engines in daily operation, 76*; aggregate number of horse powers, 858; aggregate number of gallons of water used per day, of 10 hours, 60,385.

Which, in the event of your deeming worthy of an insertion in your columns, will not only be a source of gratification to me, in having added to your useful work, but will be the means of eliciting some further contributions, at no very distant period, from A YOUNG ENGINEER.

New-York, July 20, 1835.

* From 8 to 12 have been erected since.

[From the London Penny Magazine.]

MR. JOHN LOMBE, AND THE SILK-THROWING MACHINERY AT DERBY.—The Lombes were originally manufacturers at Norwich, but removed to London, and became silk throwsters and merchants there. There were three brothers, Thomas, Henry, and John; the first was one of the sheriffs of London at the accession of George II. in 1727, on which occasion, according to custom, the chief magistrate was created a baronet, and Mr. Lombe was knighted. The second brother, who was of a melancholy temperament, put an end to his existence before those plans were developed which connected the name of Lombe with one of the most important manufactures of the country.

The Messrs. Lombes had a house at Leghorn under the firm of Glover & Unwin, who were their agents for purchasing the raw silk which the Italian peasantry sold at their markets and fairs to the merchants and factors. There were many other English houses at Leghorn, Turin, Ancona, and other parts of Italy, chiefly for exporting silk to England, in part return for which numerous cargoes of salt fish were and still are received from our ports for the consumption of the Italians during their Lent and other fasts. It was at that time customary for the English merchants engaged in the Italian trade to send their apprentices and sons to the Italian ports to complete their mercantile education, by acquainting themselves on the spot with the details of their peculiar line of business. It was professedly in compliance with this custom, but with a deeper ulterior view, that the youngest of the brothers, Mr. John Lombe, who at that time was little more than twenty years of age, proceeded to Leghorn in the year 1715.

The Italians had at that time become so much superior to the English in the art of throwing silk, in consequence of a new invention, that it was impossible for the latter to bring the article into the market on equal terms. This state of the trade induced the Lombes to consider by what means they might secure the same advantage which their improved machinery gave to the Italians; and the real view of the younger brother, in proceeding to Italy, was to endeavor to ob-

tain such an acquaintance with the machinery as might enable him to introduce it into this country. The difficulties in the way of this undertaking were very great, and would have appeared insurmountable to any but a person of extraordinary courage and perseverance. We find these difficulties thus stated in the paper which Sir Thomas Lombe printed for distribution among the members when he applied to Parliament for the renewal of his patent. One at least of these printed papers has been preserved, and has been lent us for the present occasion. It is there said, that "the Italians having, by the most judicious and proper rules and regulations, advanced and supported the credit of the manufacture, have also, by the most severe laws, preserved the mystery among themselves for a great number of years, to their inestimable advantage. As, for instance, the punishment prescribed by one of their laws for those who discover, or attempt to discover, any thing relating to this art, is death, with the forfeiture of all their goods, and to be afterwards painted on the outside of the prison walls, hanging to the gallows by one foot, with an inscription denoting the name and crime of the person; there to be continued for a perpetual mark of infamy."

The young Lombe, however, was not to be deterred by the danger and difficulty of the enterprise. On his arrival, and before he became known in the country, he went, accompanied by a friend, to see the Italian silk works. This was permitted under very rigid limitations. No person was admitted except when the machinery was in action, and even then he was hurried through the rooms with the most jealous precaution. The celerity of the machinery rendered it impossible for Mr. Lombe to comprehend all the dependencies and first springs of so extensive and complicated a work. He went with different persons in various habits, as a gentleman, a priest, or a lady, and he was very generous with his money; but he could never find an opportunity of seeing the machinery put in motion, or of giving to it that careful attention which his object required. Despairing of obtaining adequate information from such cursory inspection as he was thus enabled to give, he bethought himself of associating with the clergy, and being a man of letters, he succeeded in ingratiating himself with the priest who confessed the family to which the works belonged. He seems to have opened his plans, partly at least, to this person, and it is certain that he found means to obtain his co-operation. According to the scheme which they planned between them, Mr. Lombe disguised himself as a poor youth in want of employment. The priest then introduced him to the directors of the works, and gave him a good character for honesty and diligence, and described him as inured to greater hardships than might be expected from his appearance. He was accordingly engaged as a fillatoe-boy, to superintend a spinning engine so called. His mean appearance procured him accommodation in the place which his design made the most acceptable to him,—the mill. While others slept, he was awake, and diligently employed in his arduous and dangerous undertaking. He had possessed himself of a dark lantern, tinder box, wax candles, and a case of mathematical instruments: in the day time these were secreted in the hole under the stairs where he used to sleep; and no person ever indicated the least curiosity to ascertain the extent of the possessions of so mean a lad. He thus went on making drawings of every part of this grand and useful machinery; the priest often inquired after his poor boy at the works, and through his agency Lombe conveyed his drawings to Glover and Unwins; with them models were made from the drawings, and dispatched to England piecemeal in bales of silk. These originals are still, we believe, preserved in the Derby mills.

After Lombe had completed his design, he still remained at the mill, waiting until an English ship should be on the point of sailing for England. When this happened, he left the works and hastened on board. But meanwhile his absence had occasioned suspicion, and an Italian brig was dispatched in pursuit; but the English vessel happily proved the better sailer of the two, and escaped. It is said that the priest was put to the torture; but the correspondent of the "Gentleman's Magazine," to which we are indebted for most of the facts we have stated, says that after Mr. Lombe's return to England, an

Italian priest was much in his company; and he is of opinion that this was either the priest in question, or at least another confederate in the same affair. Mr. Lombe also brought over with him two natives accustomed to the manufacture, for the sake of introducing which he had incurred so much hazard.

After his return Mr. John Lombe appears to have actively exerted himself in forwarding the works undertaken by him and his brother, Sir Thomas, at Derby; but he did not live to witness their completion. He died on the premises, on the 16th of November, 1722, in the 29th year of his age. The common account of his death is, that the Italians, exasperated at the injury done to their trade, sent over to England an artful woman, who associated with the parties in the character of a friend; and having gained over one of the natives who originally accompanied Mr. Lombe, administered a poison to him of which he ultimately died.

We recur to Sir Thomas Lombe's statement, already quoted for the most authentic particulars respecting the progress of the work. The document itself is entitled, "A Brief State of the Case relating to the machine erected at Derby, for making Italian Organzine Silk, which was discovered and brought into England with the utmost difficulty and hazard, and at the sole expense of Sir Thos. Lombe." It commences with stating the capabilities of the machine. "This machine performs the work of making Italian organzine silk, which is a manufacture made out of fine raw silk, by reducing it to a hard twisted, fine, and even thread. This silk makes the warp, and is absolutely necessary to mix with and cover the Turkey and other coarser silks thrown here, which are used for shute; so that without a constant supply of this fine Italian organzine silk, very little of the said Turkey and other silks could be used, nor could the silk-weaving trade be carried on in England. This Italian organzine (or thrown) silk has in all times past been bought with our money, ready made (or worked) in Italy, for want of the art of making it here; whereas now, by working it ourselves out of fine Italian raw silk, the nation saves nearly one third part; and by what we make out of fine China raw silk, above one half of the price we pay for it ready worked in Italy." The paper goes on to state, that "the machine at Derby has 97,746 wheels, movements, and individual parts, (which work day and night,) all which receive their motion from one large water wheel, and are governed by one regulator; and it employs 300 persons to attend and supply it with work." After stating the difficulties which had been surmounted in introducing this improvement, the paper thus concludes: "Upon the introduction of which [this improvement], his late most gracious Majesty granted a patent to the said Sir Thomas Lombe, for the sole making and use of the said engines in England, for the term of fourteen years. Upon which he set about the work and raised a large pile of building upon the river Derwent at Derby, and therein erected the said machine; but before the whole could be completed, several years of the said term were expired. Then the King of Sardinia, in whose country we buy the greater part of our supply of organzine silk, being informed of his success, prohibited the exportation of Piedmontese raw silk; so that before the said Sir Thos. Lombe could provide a full supply of other raw silk proper for his purpose, alter his engine, train up a sufficient number of workfolk, and bring the manufacture to perfection, almost the whole of the said fourteen years were run out. Therefore, as he has not hitherto received the intended benefit of the aforesaid patent, and in consideration of the extraordinary nature of his undertaking, the very great expense, hazard, and difficulty, he has undergone, as well as the advantage he has hereby procured to the nation at his own expense, the said Sir Thomas Lombe humbly hopes the parliament will grant him a further term for the sole making and using his engines, or such other recompense as in their great wisdom shall seem meet."

The Parliament considering the matter of much public importance, thought it best to give him a grant of £14,000, on condition that the invention should be thrown open to the trade, and that a model of the machine should be deposited in the Tower of London for public inspection. It is commonly stated that Parliament refused

to extend the patent, and granted the money to soften their refusal; but we have seen that Sir Thomas himself suggested some "other recompense" than an extended patent as an alternative. In the course of time similar mills began to be erected in different parts of the country; but in consequence of the difficulties that were experienced in procuring Italian raw silk of the proper size for organzine, (the exportation of which was prohibited by the Italians,) and also because the mills happened subsequently to find employment for other purposes, the quantity worked into organzine, in this country, bore for many years no proportion to the imports from Italy. The manufacture has, however, been since revived and improved. In consequence of which it is now carried on to a very considerable extent, not only in Derby, but in other parts of the country.

The mill erected by Sir Thos. Lombe stands upon an island, or rather swamp, in the Derwent, about 500 feet long and 52 wide. The building stands upon huge piles of oak, double planked, and covered with stone-work, on which are turned thirteen stone arches, that sustain the walls. Its length is 110 feet, its breadth 39, and its height 55 feet. It contains five stories. In the three upper are the Italian winding engines, which are placed in a regular manner across the apartments, and furnished with many thousand swifts and spindles, and engines for working them. In the two lower floors are the spinning and twist mills, which are all of a circular form, and are turned by upright shafts passing through their centres and communicating with shafts from the water wheel. The spinning mills are eight in number, and give motion to upwards of 25,000 reel-bobbins, and nearly 3000 star-wheels belonging to the reels. Each of the four twist mills contains four rounds of spindles, about 389 of which are connected with each mill, as well as numerous reels, bobbins, star-wheels, &c. The whole of this elaborate machine, though distributed through so many apartments, is put in motion by a single water wheel, twenty-three feet in diameter, situated on the west side of the building. All the operations, from winding the raw silk to organizing or preparing it for the weavers, are performed here. The raw silk is chiefly brought in skeins or hanks from China and Piedmont. The skein is, in the first instance, placed on a hexagonal wheel, or swift, and the filaments which compose it are regularly wound off upon a small cylindrical block of wood, or bobbin. It is the work of five or six days to wind a single skein, though the machine be kept in motion for ten hours daily, on account of the amazing fineness of the filaments of which it consists. The silk, when thus wound off upon the bobbins, is afterwards twisted by other parts of the machinery, and is then sent to the *doublers*, who are chiefly women stationed in a detached building. Here four, seven, or ten threads, are twisted into one, according to its intended size, the fine kind going to the stocking weavers, and the others to different manufacturers. Other mills erected more recently at Derby, on a similar principle, greatly surpass this in their machinery, and efficiency; but the old mill must continue to be regarded with peculiar interest, as the first establishment of the kind erected in this country.

[For the Mechanics' Magazine.]

Speedwell Iron Works.—Speedwell is a small village situated on the Whippany river, about one mile from the pleasant town of Morris, Morris county, N. J., and celebrated for its manufactories of machinery. Located as it is in the very heart of an iron region, and supplied with an unfailing water power, it has advantages for the making of machinery which few works possess. They have been in operation thirty years, and have acquired, from the superior quality of the work, in strength, durability, and finish, extensive patronage and celebrity. The enterprising and intelligent proprietors, S. Vail & Son, having gradually enlarged the works from their commencement, and improved the machinery as the times demanded, have spared no pains in providing the manufactories with every kind of apparatus which is necessary for the execution of the most difficult pieces of work, and with the greatest care and dispatch. At present the works consist of several shops, in which machinery in its various stages is made. The first is the forging department, where, by peculiar facilities

and helps, afforded by the locality of the establishment, its water power, driving a trip hammer and also a pair of bellows, supplying all the fires with wind, its cranes and railways, is made the heaviest and most unyielding pieces of machinery. The next branch is its finishing departments, which are three. Every advantage is also here taken of its water power, and its apparatus for finishing is simple and effective. It has also a brass-foundry, and an iron-foundry erecting, a factory for spinning cotton not yet finished, a sash factory in full operation, where the mortices, tenons, &c. are made by machinery, and a saw-mill. The village is quite romantic, and its scenery enchanting—surrounded on every side by steep and high hills, overlooking the busy scenes below, and the spacious lake which spreads before the eye in beauty, embosomed between two large hills, whose verdant and woody sides slope to the water's edge. [For a view of this establishment see engraving.]

Silversmith's Portable Forge.—We were much pleased with the examination, at the machine shop of Mr. G. N. Miner, No. 30 Gold street, of a *Portable Forge* for the use of jewellers and others who require a small manageable fire. It consists, first, of a cast iron fireplace, much resembling a Franklin stove, with a pot, about the size and shape of the crown of an old-fashioned quaker hat, inverted, and attached to the bottom of the hearth of the stove, into which is inserted a tin air pipe, leading from the bellows, contained in a box of 37 inches long, 24 inches wide, and 16 inches deep, upon the top of which the forge or stove stands, occupying very little space, and it may be moved by one man to any part of the shop. The bellows is put in motion by the foot of the man who uses the forge. This very convenient apparatus was invented, we are informed, by Mr. ———, of Peekskill, Westchester county, New-York, and one of them may be examined at No. 30 Gold street, to which we would call attention.

[For the Mechanics' Magazine.]

Mr. Burden's Spikes. — The public has already had the means of knowing that the above named enterprizing individual invented, some years since, a machine for making spikes of wrought iron, chiefly for the purposes of being used in constructing ships and railroads; but their value, compared with other spikes, seems to be but very sparingly known. These spikes, to any competent judge, will show themselves to be far superior to any spikes ever manufactured, or which can be manufactured for the above purposes, for the following reasons. The iron being selected by Mr. B. himself, and in large quantities of the first quality, no other being used, its uniform excellence must infinitely surpass that of common spikes, which are made of such small lots of iron as come to hand promiscuously; the body of these spikes being of exactly even and uniform size, and without hammer strokes, when once entered they have no tendency to split the wood, and, having a square chisel shaped edge, they cut their passage instead of forcing it.

But Mr. B. is emphatically an experimentalist, and he wished to test the comparative value of his spikes by some precise data. He wished to ascertain first with what degree of safety his spikes might be driven into wood without splitting; second, what was the tenacity of the iron; and third, what power it would require to draw them out.

To test the first point, he took a piece of seasoned white oak joist, 3 by 6 inches, and sawing off 3 inches, produced, of course, a piece 3 inches square and 6 inches long, but with the grain running crosswise. In one end of this block, he entered, without boring, the point of a spike 5 inches long, with the edge of its point across the grain, and drove in the whole length without splitting the block.

To ascertain the second and third points, he drove another and similar spike into a similar block, leaving its head a little distance out, and securing the block in a firm situation, and griping the head by a strong instrument similar to a pair of wire tongs, he suspended to the tongs 100 56-pound weights, equal to 5600 pounds, and these neither breaking the spike nor

drawing it out, he took a sledge and struck forcibly upon the apparatus attached to the head of the spike, when it drew out and left the spike and the wood unbroken.

These experiments were made at the store of Messrs. I. & J. Townsend, in this city, in presence of the President and Directors of the Albany and Schenectady Railroad Company, and if they do not remove all doubts as to the superiority of these spikes for ships and railroads, I know not what would. S. B.

Albany, June 15, 1835.

[For the Mechanics' Magazine.]

TABLE,

Showing the proper number of turns or twists to an inch in Cotton Warp for every degree of fineness, or number of skeins to the pound, from 1 to 200.

1	5.	31	27.83	61	39.05	91	47.69
2	7.07	32	28.28	62	39.37	92	47.95
3	8.66	33	28.72	63	39.68	93	48.22
4	10.	34	29.15	64	40.	94	48.47
5	11.18	35	29.57	65	40.3	95	48.73
6	12.24	36	30.	66	40.62	96	48.98
7	13.22	37	30.41	67	40.92	97	49.24
8	14.14	38	30.82	68	41.28	98	49.49
9	15.	39	31.22	69	41.53	99	49.74
10	15.81	40	31.62	70	41.83	100	50.
11	16.58	41	32.01	71	42.12	105	51.23
12	17.32	42	32.4	72	42.42	110	52.43
13	18.2	43	32.83	73	42.72	115	53.61
14	18.72	44	33.16	74	43.01	120	54.77
15	19.36	45	33 54	75	43.3	125	55.90
16	20.	46	33.91	76	43.58	130	57.
17	20.61	47	34.26	77	43.87	135	58.07
18	21.21	48	34.71	78	44.13	140	59.16
19	21.79	49	35.	79	44.41	145	60.2
20	22.35	50	35.35	80	44.72	150	61.23
21	22.91	51	35.7	81	45.	155	62.24
22	23.45	52	36.05	82	45.27	160	63.24
23	23.97	53	36.41	83	45.55	165	64.22
24	24.13	54	36.74	84	45.82	170	65.19
25	25.	55	37.08	85	46.09	175	66.12
26	25.5	56	37.41	86	46.36	180	67.08
27	25.98	57	37.71	87	46.63	185	68.
28	26.45	58	38.07	88	46.9	190	68.92
29	26.92	59	38.4	89	47.17	195	69.82
30	27.15	60	38.72	90	47.4	200	70.86

Mr. S. Blydenburgh: Sir,—A difficulty is often experienced in cotton spinning manufactories, not only at their first starting, but frequently afterwards, owing to the overseer not knowing how to calculate the precise quantity of twist for any given number or size of yarn. To remedy this difficulty, you may insert, if you think proper, the enclosed table in the Mechanics' Magazine, which will show the number of turns or twists per inch, to make the yarn to be spun agree in its proportion of twist with the sample given.

Example. The most approved quantity of twist, or rate of twisting, within the circle of my acquaintance, is 20 turns per inch for warp yarn No. 16, and other numbers in proportion. Now, to come at this proportion, I extract the square root of the number to be spun and multiply it by 5, and the product is the number of turns required. Suppose the number of the yarn required to be spun is 64—then the square root of 64 is 8, which, multiplied by 5, gives 40 for the appropriate number of turns to the inch for yarn No. 64—and the same of any other number.

I have given the fractional parts of the number of turns in decimals, omitting what is over 2 places, or omitting thousandth parts of a turn, as so small a fraction of a turn can be of no consequence. Your obedient servant,

Augustus Green.

Scituate, R. I.

Remarks.—The communication and table from Mr. Green, I think, cannot fail to be acceptable to cotton manufacturers, as I have found but very few overseers of spinning rooms who knew how to come at the knowledge it contains. Mr. G.'s table, I would notice, however, giving a little more twist than I have been in the habit of giving, when engaged in cotton manufacturing, but this is mere matter of opinion. I have no doubt that 20 turns to the inch to No. 20, which is the proportion of twist that I have given, will make rather the smoothest goods, but 20 turns to No. 16 will have the advantage in strength; but this table can be adjusted to any quantity of twist. The principle is, that an inch of cotton thread is a cylinder an inch long, and the solid contents of two cylinders of the same length are to each other as the square of their diameters. Hence, if a thread of No. 16 be of a given diameter,

one of half the diameter would have but one fourth of the weight, and consequently would be No. 64. But the quantity of twist requires to be in the direct proportion to the diameter.

In Mr. G.'s table, he allows 20 turns to the inch of No. 16, which is equal to the square root of 16, multiplied by 5, and the proportion will hold good with any other number by multiplying its root by the same multiplier, and the relative quantity of twist may be varied by using any other multiplier. For example : If it were wished to give No. 16 only 16 turns, then as the root of 16 multiplied by 4 equals 16, the root of any other number, multiplied by 4, would give the same proportion of twist. If instead of multiplying by 4 or by 5, any intermediate fractional part between 4 and 5, as 4·3, or 4·5, be used, the twist may be varied accordingly. Multiplying the root of the number of yarn by 4·5, or $4\frac{1}{2}$, gives a small fraction over 20 turns to the inch of yarn No. 20.

S. Blydenburgh.

[From the Apprentice's Companion.]

Mr. S. Blydenburgh : Sir,—Deeming it not an unimportant matter, I take the liberty of presenting you a few remarks, intended for the Apprentice's Companion, respecting the formation of our Apprentices' Society, and the establishment of a reading room and apprentices' library in Albany, hoping the example may induce others to do likewise.

Being in the city of Philadelphia in 1829, I was invited by a friend to accompany him, to hear an address by Rev. Mr. Bacon, to the congregation of apprentices of that city, and I accordingly went, and can truly say I never before witnessed a scene to me so pleasingly interesting. To see 150 young men, conducting not only with the utmost decorum, but with apparent marks of sincere devotion; and when the service ended, instead of rudely rushing to the doors, to see who would get out first, to see them rise in small numbers at a time, and walk out in the most respectful manner, was, to me, not only a pleasing but a charming sight.

On returning home, fired with a zeal for the youth of our city, I made application to the Common Council for a room in the Lancaster building, which was granted and fitted up by them. A society was formed, and a reading room opened every night in the week; since which time the affairs of the society have gradually, though not steadily, progressed to their present state. After being closed one year, the library was removed to its present location, in February, 1831. From this time to the close of the year, 1754 books were drawn out; in 1832, 5000; in 1833, 11,343; in 1834, 10,276; in 1835, up to June 31, 4,831; and is still increasing in magnitude and effect.

James S. Gould, Librarian.

[From the Apprentice's Companion.]

Mr. Editor,—In your second number I addressed a few remarks to apprentices on the importance of studying grammar; permit me now to address to that important class of community a few plain, practicable observations. My remarks and advice may appear trite, but I hope they will be well pondered by those for whom they are intended. At present there seems an awakening in our country to the moral improvement of mechanics. If this is so, (and I believe it to be the case,) I hope a word of caution to apprentices will not be taken amiss by any one: it is the danger of considering *that* mental improvement which whets the mind for disputation on abstract questions. This, instead of enlightening, bedizens the mind. To become fond of it, and be much engaged in controversies of this kind, is perverting the noblest faculty bestowed on man by his Creator, especially disputations on religion. Religion, properly understood, is chastened thinking and feeling; and how can these be debateable ? Study the example and precepts of Christ, as you find them yourselves in the New Testament, and avoid the worse than useless sectarian disputations. So far is it from my aim to dissuade from, that I most earnestly recommend, regular attendance at public divine worship; but avoid denunciating sectarian pulpits. They debase the heart, and destroy the good will of man to man.

There is an old saying, that "when the boy assumes the man, the man will play the boy." Another, "a forward boy makes a froward man." I quote these old sayings, not to discourage boys from endeavoring to store their minds with as much of the knowledge that appertains to, and can be expected from, men only; but to guard them against the too common fault of supposing themselves possessed of that after which they have only commenced the pursuit. An ancient philosopher has said, "I have lived to threescore years and ten to learn to know that I know nothing." What presumption, then,

for boys to flatter themselves that they know too much to be taught by men! That some boys have thus deceived themselves to their injury, nay, sometimes to their destruction, my own observation can bear testimony.

"It is much easier to learn than to unlearn bad habits:" this the experience of life teaches. How necessary, then, for every boy, when he first leaves the parental roof to learn a trade by which he hopes to make a comfortable livelihood, that he should so form his habits as to insure success; and this can be done only by conducting himself in such a way as to command respect for himself, and by cherishing the noble feeling of adding respectability to his calling.

An important consideration for a boy, when he first enters a shop, next to obtaining the good opinion of his master, is the conciliating that of the journeymen; for he ought to know, that it is not in the power of a master to teach himself, directly, all the minutiæ of his business to every apprentice he may have. The boy must observe for himself; and any thing he does not understand, he can learn from journeymen, or older apprentices, by a frank inquiry, if he shows in his conduct that he is deserving of it. Almost every man, whatever his general deportment may be, is gratified to give information to a boy, when it is asked with sincerity, and an evident desire for improvement. When advice is given, although it may appear at the time that not much knowledge has been imparted, receive it kindly and thankfully; in after years you may highly appreciate it.

It has been said, "There is no royal road to science;" nor can a man be a good mechanic by intuition. The proverb, "Little strokes fell great oaks," may be truly applied to the acquisition of mechanical knowledge, which, to be permanently useful, must be attained gradually. This fact ought not to dishearten the young apprentice, for he will soon find that every new acquisition of knowledge in his trade is a new incentive to exertion, and that progressing in knowledge is the most solid happiness of life.

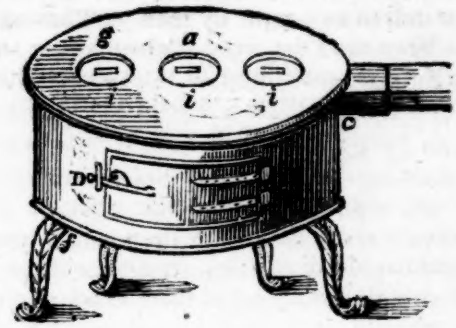
Giving each other nicknames is a vulgar habit to which boys are much addicted. It should be avoided, for it frequently causes wrangling and fighting, and destroys friendships that might otherwise be advantageously cemented through life.

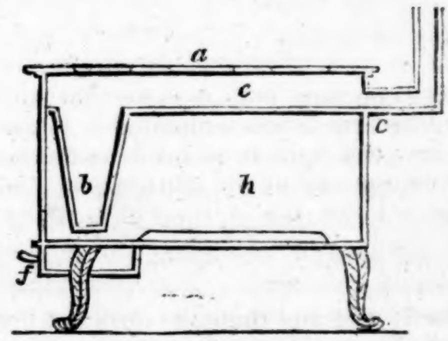
Avoid also the frequent use of by-words: they may be, and many of them are, harmless; but the habit is vulgar, and degrades you in the estimation of the more thinking part of the community. Above all, do not get in the habit of interlarding your conversation with oaths: this, to say nothing of the blasphemy, is detestable in every respect; nothing is more grating to the feelings of a man of sense. "Swear not at all," is a command in Holy Writ. Read the sacred volumes with attention; maxims are there to be found more profitable in life, if correctly understood and acted up to, than can be found any where—every where else.

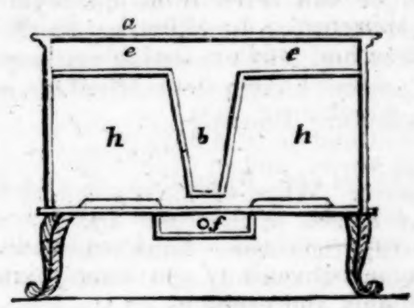
A Mechanic.

Number of Living Beings. — The immense multitude of animated beings which people the earth, and the ample provision that is made for their necessities, furnish irresistible evidence of the divine goodness. It has been ascertained that more than sixty thousand species of animals inhabit the air, the earth and the water, besides many thousands which have not come within the observation of the naturalist. On the surface of the earth there is not a patch of ground, nor a portion of water, a single shrub, tree, or herb, and scarcely a leaf in the forest, but what teems with animated beings. How many hundreds of millions have their dwellings in caves, in the clefts of rocks, in the bark of trees, in the ditches, in the marshes, in the forests, the mountains, and the valleys! What innumerable shoals of fishes inhabit the ocean, and sport in the seas and rivers! What millions of millions of birds and flying insects, in endless variety, wing their flight through the atmosphere above and around us! Were we to suppose that each species, on an average, contains four hundred millions, there would be twenty four billions of living creatures belonging to all the known species inhabiting the different regions of the world, besides the multitude of unknown species yet undiscovered, which is 30,000 times the number of all the human beings that people the globe. Besides these, there are multitudes of animated beings which no man can number, invisible to the unassisted eye, and dispersed through every region of the earth, air, and seas. In a small stagnant pool, which in summer appears to be covered with green scum, there are more microscopic animalcules than would outnumber all the inhabitants of the earth. How immense then must be the collective number of these creatures throughout every region of the earth and atmosphere! It surpasses all our conceptions. Now it is a

fact, that from the elephant to the mite—from the whale to the oyster—from the eagle to the gnat, or the microscopic animalcule—no animal can exist without nourishment. Every species too requires a different kind of food. Some live on grass, some on shrubs, some on flowers, and some on trees. Some feed on the roots of vegetables, some on the stalk, some on leaves, and some on the fruit, some on the seed, some on the whole plant; some prefer one species of grass, some another. Yet such is the undoubted munificence of the Creator, that all the myriads of sentient beings are amply provided for and nourished by his bounty! "The eyes of all these look unto him, and he openeth his hand, and satisfieth the desires of every living thing." He hath so arranged the world, that every place affords the proper food for all the living creatures with which it abounds. He has furnished them with every organ and apparatus of instruments for gathering, preparing, and digesting their food, and has endowed them with admirable sagacity in finding out and providing their nourishment, and in enabling them to distinguish between what is salutary and what is pernicious. In the exercise of these faculties, and in all their movements, they appear to experience a happiness suitable to their nature.







The Bruges Stove, as improved by Messrs. Cottam and Hallen. By Mr. Edward Cottam.—I send you sketches (figs. 1, 2, 3,) of the Bruges stove, as manufactured by Cottam and Hallen, who have found it to answer fully the statement given by them of it in your Encyclopedia of Achitecture. It will do more with a given quantity of fuel than any other stove, having the means of stewing, boiling, broiling, roasting, and baking, at one and the same time, with a small quantity of coke or cinders from any other fire.

It is simple in form, and there is not the slightest difficulty in its use. The holes in the top may be arranged as is found most convenient for the situation in which the stove is to be placed, either in a line, as in the sketch, (fig. 1,) or in the form of a triangle. One thing is indispensable for the proper action of this stove, and that is a good draught. It must, therefore, have a separate flue.

In figs. 1, 2, 3, *a* is the top of the stove; *b* is the fire pot; *g* is the hole for feeding the fire pot; *f* is an ash drawer; *c* is the flue; D is the oven door; *h* is the oven; *e* is a space for the fire to pass to the flue *c*, and for heating the whole of the top plate, any part of which will produce sufficient heat for culinary purposes; *i i i* are lids, which may be taken off, and the battery of stew-pans, or boilers, will then be in contact with the flame. A grid-iron fits on any of these openings, which has the advantage of not smoking the article broiled, the draught being downwards.—[Loud. Arch. Mag.]

Malleable Iron.—Though the manufacture of iron belongs to the department of useful arts, the process by which refuse and scraps of all kinds are converted into a malleable mass, is rightly embraced under chemical manipulations. Within a comparatively little time, a costly establishment has grown up at East Boston, called the Malleable Iron Manufactory, in which it is generally understood that various cutlery is to be made from such ap-

parently worthless materials as have here been adverted to. It was remarked in our hearing, that an old door hinge, originally cast iron, had been converted into a razor; and that a certain individual, whose name had not been ascertained by the gentleman who gave the above information, alone possessed the skill of performing these apparently impossible transmutations of a brittle, irregular grained cast metal, into finely tempered cutting instruments.

From the magnitude of the preparations in progress, as it regards buildings, the erection of a wharf and dwellings for the operatives, it is very certain that an active business is contemplated. By looking into the third volume of the Scientific Tracts, as well as the Museum of Arts, it appears to us that all that is known of the best methods of managing iron and steel is plainly exhibited. The carbonization of the article is the object, and the working-secret at this manufactory must consist, therefore, in effecting this in a speedier and less expensive manner than is at present known to practical chemists. —[Scientific Tracts.]

Hydrostatic Pressure on the Eyes of Whales.—Admitting a cubic foot of fresh water weighs sixty-five pounds, and the same measure of sea water, sixty-six and a half, the pressure on the bodies of marine animals must indeed be great. Were a cubic foot of the latter to weigh exactly sixty-six pounds, at the depth of 8400 feet, the pressure must be the enormous weight of 554,400 pounds. Whales have occasionally run out fourteen warps of a hundred fathoms each, which, if the descent be perpendicular, is just equal to 8400 feet. However, it is probable that this course is usually at an inclination of between seventy and eighty degrees from a vertical line, but arriving nevertheless, at depths much beyond ordinary soundings. Supposing the eye of the whale exposes to the water six square inches in its entire superficies, when the monster dives to the depth to which it has been assumed that he has the power of going, the hydrostatic pressure on the eye will be equal to 23,100 pounds. Six square inches are the twenty-fourth part of a square foot; and at 8400 feet, the weight being 554,400 pounds, it follows, therefore, that the eye resists the force or pressure of just 23,100 pounds.

When a tightly corked bottle is sunk one hundred fathoms, at sea, the cork has invariably been forced in, and the bottle found full of water, when brought to the surface. If the cork be capped wtih sealing wax, on coming up it will be inverted, the sealed end being downward. On the other hand, if nothing is applied, then the cork will generally have a horizontal position. These experiments, however, have been so frequently made, that they have ceased to be interesting to philosophers.—[Ibid.]

[From the London Mechanics' Magazine.]

STEREOTYPE SUBSTITUTES.

Sir,—A writer in your Monthly Part for January, alludes to the probability of an invention by which the letters may be transferred from printed books to a kind of stereotype plates, by which copies may be infinitely multiplied, without a new composition or re-setting of types. Chemistry will no doubt add this to the numerous obligations it has already conferred upon the world; and the printing once transferred, the Chinese, or indeed the lithographic printing, may satisfy us, that the letters will be sufficiently in relief. The letter of your correspondent has suggested to me a question, whether lithography does not already supply us with a cheap mode of preserving a fac-simile copy of any types which have once appeared in the page of the printing compositor? What objection would there be to keep a copy of any printed page on transfer paper? Letter-press printing has long been successfully transferred to the lithographic stone, and if the copy taken off on transfer paper would keep for any length of time, we might, at very trifling expense, produce a few copies of a work, whenever they were wanted. I hope some of your scientific readers, who have made chemistry their study, will be so obliging as to solve this question: whether a copy made on transfer paper will keep for any length of time without being decomposed? In many cases the benefit to the literary world would be very great, from having the means of keeping (and renewing) a copy of a printed page, for immediate use, as type, in a space scarcely greater than

that occupied by a printed book, and from it to have the power of producing copies, at an expense not worth any consideration, when compared with the cost of re-setting the press. I am, &c. B. S.

Effects of Lightning.—The Boston Traveller says: Our readers will be interested in the following account of a scientific examination of the several buildings in this vicinity, injured by lightning during the storm of the 13th ult. It is from the pen of a practical electrician, well known in this community, who has been eminently successful in his researches, and who seems at length to have perfected the application of metallic rods to the prevention of dwellings from damage by lightning. It is certainly very remarkable, as mentioned below, that of four buildings struck, three should have been furnished with the round rod so common in most parts of the country.

"Sir—By request of a number of scientific gentlemen, I proceeded in company with one of them to examine the buildings struck by lightning in this vicinity, on the afternoon of Saturday, June 13. The first was the dwelling house of Professor Palfrey, at Cambridge. The Professor politely accompanied us, and gave all the information required. This building had a round lightning-rod, with points at the top, but blunt in the ground. It was affixed to the back part of the building. In this examination, I was satisfied that the discharge of lightning was horizontal, from one cloud to another, taking the earth in its course. Passing over the points of the rod, it was attracted by them, passed down the rod to the upper part of the lower story; here it left, and struck into the building, passing through various parts and rooms by the bell wires, which were melted and otherwise destroyed. It left the house by the front door. In one remarkable instance, the lightning passed by the side of a door on a bell wire, which it melted, spreading the oxide of the wire on the plastering in its passage.

"From this building we proceeded to Brighton, and examined the meeting-house of the Rev. Mr. Austin. Here I was again satisfied that the discharge of lightning was horizontal; being received on the points of the round rod, it passed down the rod to the side of the building opposite the stove funnel, when it struck into the building, taking the stove funnel in its course, and passed down on one of the supporting pillars of the gallery, and off to the ground on one of the beams that supported the floor.

"Some days after, I visited the meeting-house near the bridge in Braintree, which was struck by lightning during the same storm. This house had also a round rod, pointed at the top and blunt in the ground. Such rods afford but an imperfect protection. In this instance, the earth about the conductor was considerably disturbed. About ten feet from the ground, near the rod, there was a perforation in the side of the building, where the lightning entered and passed under the stairway that leads to the gallery, and through the partition to an iron brace that supported the stove funnel. It then appears to have passed on the funnel to another brace, that was secured to one of the pillars, on which it descended, shattering it to pieces. The pillar opposite was also a little damaged; and other trifling injuries appeared about the building.

"I have also examined a dwelling house at Brookline, that was considerably damaged by lightning at the same time. This house had no conductor. The lightning struck a large tree in front of it, which it evidently left and descended on the building.

"During this thunder storm, we have three instances out of four, where houses having round conductors were struck by lightning, and where, it is evident, the rods afforded but little or no protection. The cause to me is very plain. In the first place, the number of rods is not sufficient. Secondly, they do not present in all directions a sufficient attracting power; and thirdly, they are in most cases put upon buildings by persons who are not familiar with the science of Electricity and the operations of lightning; and who of course are liable to leave them faulty in many very essential particulars.

"During thunder storms, there are three different discharges of lightning—from the earth to the clouds—from the clouds to the earth,—and through the atmosphere from one cloud to another. These latter discharges are more frequent than any other, and often take the earth

in their course, and were by the philoso phers of the last century called rebounding strokes of lightning. To meet these various discharges of lightning, we must have conductors armed at all parts—that is, they should present in all directions an attracting influence, by which the electric fluid may be discharged gradually and silently, without an explosion. The explosion prevented, all harm is prevented. This attracting, or receiving power, as it is more properly termed, depends on the points; hence the greater the number of points and sharp and rough corners, the greater the protecting power. Conductors should not only be armed with these numerous points, and should be pointed on the ground, but they should be placed upon the most exposed parts of the building. This requires the judgment of a person acquainted with the operations of lightning, and the nature of different substances to conduct it. Let such rods be placed on our buildings, under the direction of an experienced electrician, and we shall no more hear of lightning leaving the rod and striking into the building.

"Certain trifling things have been considered necessary for lightning conductors; such as silvering the points—pieces of glass to prevent the lightning from entering the building—and surrounding the lower extremity of the rod with charcoal. These are of no use whatever. That round rods with their silver points, their glass fastenings, and the lower end surrounded with charcoal, do not afford sufficient protection, is evident from the fact, that a great proportion of the houses struck by lightning are houses professedly protected by such rods. That the square rod with the numerous points and sharp corners does most effectually protect a building, may be easily proved by experiments with an electrical machine, to the satisfaction of every unprejudiced person. Another consideration of some importance in favor of these rods, is the fact, that of more than two thousand houses thus protected, I have never known an instance where the building was in the least injured. These rods discharge the electric fluid without an explosion, and consequently without harm."

How to insure Success.—The surest way not to fail is to determine to succeed.—[Sheridan.]

Experiments on the Transverse Strength and other Properties of Malleable Iron, with Reference to its Uses for Railway Bars. By Peter Barlow, F. R. S., Cor. Mem. Inst. of France; of the Imp. and Roy. Acad. of Petersburgh and Brussels, etc.

In order to render some remarks and observations in the following pages intelligible to the general reader, it will be necessary to state a few particulars relative to the circumstances which gave rise to the experiments, and to the appearance of them in their present form.

The Board of Directors of the London and Birmingham Railway Company, desirous of carrying on the great work in which they are engaged on the most scientific principles; and, if possible, to avoid the enormous cost of repairs which has attended some large works of a similar description, offered, by public advertisement, a prize of one hundred guineas "for the most improved construction of railway bars, chairs, and pedestals, and for the best manner of affixing and connecting the rail, chair, and block, to each other, so as to avoid the defects which are felt more or less on all railways hitherto constructed;" stating, that their object was to obtain, with reference to the great momentum of the masses to be moved by locomotive steam engines on the railway,

1. "The strongest and most economical form of rail.
2. "The best construction of chair.
3. "The best mode of connecting the rail and chair; and also the latter to the stone blocks or wooden sleepers. And that the railway bars were not to weigh less than fifty pounds per single lineal yard."

In consequence of this advertisement, a number of plans, models, and descriptions, were deposited with the company within the time limited by the advertisement; and others were received afterwards, which, although not entitled to the prize, were still eligible to be considered with reference to their adoption for trial. On the 24th of December last, a resolution was passed at a meeting of the Directors, appointing J. U. Rastrick, Esq., of Birmingham, N. Wood, Esq., of Newcastle, Civil Engineers, and myself, to examine and report upon the same, with a view to awarding the prize; and, at the same time, we were requested to recommend to the Directors such plans, whether entitled to the prize or not, as might be considered deserving of a trial. We met accordingly in London; and, after a long and careful examination of the several plans, drawings, and written descriptions, recommended those we thought entitled to the prize, which was awarded by

the Directors accordingly. But that part of our instructions which required us to recommend one or more rails for trial, we were unable to fulfil to our satisfaction, principally for want of data to determine which of the proposed rails would be strongest and stiffest under the passing load, and whether permanently fixing the rail to the chair, for which there were several plans, would be safe in practice. No experiments on malleable iron having ever been made bearing on these points, it was considered better to leave the question unanswered, than to recommend, on no better ground than mere opinion, an expensive trial, which might ultimately prove a failure.

Seeing, however, how desirable it was that such data should be obtained, I proposed to the Directors to undertake a course of experiments, which should be conducted on a scale adequate to the importance of the subject, provided my Lords Commissioners of the Admiralty would allow me the conveniences His Majesty's Dockyard at Woolwich afforded, (which I had every reason to hope they would do, from the liberality I had so frequently experienced from that Board on similar occasions,) and that the Directors would supply such instruments, materials and workmanship, as might be required for the purpose.

The Admiralty, as I had anticipated, immediately granted my request; and at a public meeting of the proprietors, held at Birmingham, a resolution was passed embodying my proposition. I accordingly commenced, and continued my experiments, till I had elicited such facts as I thought necessary; and having arranged them, as in the following pages, I delivered the results, with a report founded upon them, to the Secretary of the London Committee, to lay them before the Board; which being done, the Directors were pleased to express their high approbation of my labors, and their wish that the results should be made public. I have been, therefore, induced to print them in their present form, introducing only such foot notes as seemed to me necessary to render the subject intelligible to the general reader. I have given, also, in addition, the solution of one or two equations, which, to avoid embarrassing the report, had been suppressed, the results only having been stated.

Such are the circumstances under which the following pages have been submitted to the press; and they will serve to account for the form in which the subjects are arranged, which would probably have been different, if the publication in a separate work had been anticipated in the beginning. I have no doubt, however, if the facts elicited be found useful, the form and arrangement will be considered matters of secondary consideration.

PRELIMINARY REMARKS.

It is only since the very general adoption of railways in this country, that malleable iron has been employed to any extent to resist a transverse strain, and writers who have undertaken experiments to investigate the strength of materials, have hitherto passed over those inquiries which relate to the transverse strength of this metal.* The extraordinary extent, however, to which malleable iron is now applied to resist transversely a passing load, renders it highly essential that this resistance, and its other properties, should be fully investigated; for it is obvious, that every additional weight of metal, beyond that which is requisite for perfect safety, is not only uselessly, but injuriously employed, it being generally admitted that bars beyond a certain weight cannot be so well manufactured as those of less dimensions; and it is no less certain, that by a proper disposition of the metal in the sectional area of the bar, (which depends on the data in question,) a greater strength may be obtained with a given weight of iron, than with a greater weight injudiciously disposed. Under these impressions, the following experiments have been undertaken, and to these inquiries only they have been directed; and I am not without hope that on those points they may be found useful.

Before, however, proceeding to these experimental researches, there is one subject, rather of investigation than of experiment, on which I have thought it necessary to bestow some attention, it being one on which the opinions of practical men are much divided; this is, the comparative advantages and disadvantages of what is called the fish-bellied rail, and that with parallel edges.

Examination of the Properties, Curvature, and Resistance, of the Fish-bellied Rail.

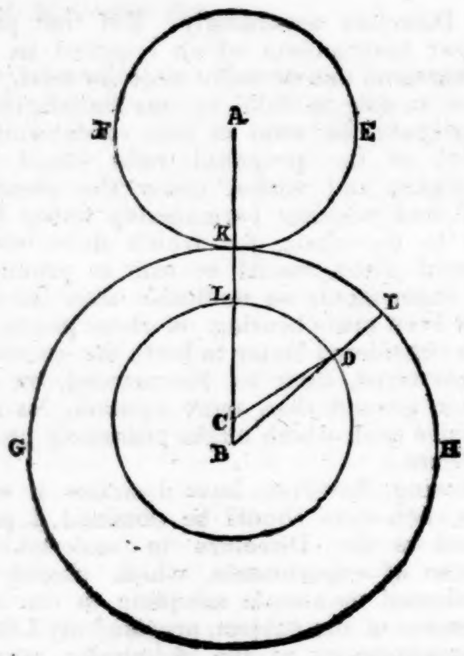
It is well known, both as a theoretical and mechanical fact, that if a beam be fixed with one end in a wall, or other immovable mass, to bear a weight suspended at the

* Some few experiments on the transverse strength of malleable iron have certainly been made. I have given three in my Essay on the Strength of Materials. Mr. Hodgkinson has also glanced at this subject in his valuable paper of Experiments on Cast Iron, published in the Memoirs of the Manchester Philosophical Society, and M. Duleau has treated of the subject in his "Essai Theorique et Experimental," &c.: but those points of greatest importance connected with the application of this metal to the purposes of Railways have never formed the subject of inquiry.

other end, the longitudinal section of such a bar (its breadth being uniform) should be a parabola; because, with that figure, every part of it will be strong in proportion to its strain, and thus one-third of the material may be saved. This form of construction is frequently adopted in the case of cast-iron beams in buildings, and with great advantage, as thereby one-third of the material is saved, while the strength is preserved, and the walls of the building relieved from a great unnecessary weight.

This seems to have led to a somewhat similar principle of construction in what is called the fish-bellied rail; and the question here is, with what advantage? In the first place, it is to be remarked that the figure, which theory requires in this case, is not, as in the preceding, a parabola; for, as in the transit of the locomotive, every part of the bar has, in succession, to bear the weight; and as the strain on any part of a beam supported at each end, and loaded in any part of its length, is as the rectangle of the two parts,—the strength being as the square of the depth,—it follows that the square of the depth ought to be every where proportional to the rectangle of the two parts, which is the known property of a semi-ellipse. The bar, therefore, in theory, ought to be a semi-ellipse, having its length equal to the transverse diameter, and the depth of the beam for its semi-conjugate, and there can be no doubt, that such a figure would be, to all intents and purposes, as strong in its ultimate resistance as a rectangular beam.

But it is difficult to obtain this figure correctly in malleable iron, and many of what are called fish-bellied rails are but bad approximations to it, although others differ from it but slightly. The following is the general mode of manufacture. [See figure.]



EF is the section of an iron roll; GH the section of another. This latter being hung on a false centre C, is turned down, leaving a groove of varying depth as shown in the figure. The cylinder GH being now again placed on its proper centre B, the bars are introduced between the two rolls at KL; and as the iron passes through, it acquires the variable depth shown in the lower roll. The inner circle, or bottom of the groove, is generally one foot in diameter, and the upper three feet in circumference; consequently, the figure is completed in a length of three feet, and there are commonly five such lengths in a bar. The computation of the ordinates to the curve thus formed is by no means difficult; for, calling the radius of the cylinder $CD=r$, and the distance of the centres $BC=d$ and x any angle LCD, we find the ordinate,

$$ID=BI-\sqrt{(r^2+d^2-2rd\cos. x.)}$$

And by this formula the ordinates of the curves have been computed for two different fish-bellied rails; the extreme depth in both being five inches, but the lesser depth in one three inches, and in the other three and three-quarter inches, the latter being that proposed by Mr. Stephenson for the London and Birmingham Railway. The ordinates are taken for each 10°, or for every inch of the half-length, and in the last column are given the ordinates of the true ellipse.

TABLE OF ORDINATES.

ABSCISSES.			Ordinates in Fish-bellied Rail. Greatest depth 5 in. Least do. 3"	Ordinates in Mr. Stephenson's Rail.	Ordinates in the Ellipse.
Deg.		In.			
0	=	0	3·00	3·75	0
10	or	1	3·01	3·76	1·64
20	··	2	3·05	3·78	2·29
30	··	3	3·12	3·82	2·76
40	··	4	3·21	3·88	3·14
50	··	5	3·31	3·95	3·46
60	··	6	3·44	4·04	3·72
70	··	7	3·59	4·14	3·96
80	··	8	3·75	4·23	4·16
90	··	9	3·92	4·34	4·33
100	··	10	4·09	4·45	4·48
110	··	11	4·27	4·55	4·61
120	··	12	4·43	4·66	4·71
130	··	13	4·59	4·75	4·80
140	··	14	4·72	4·84	4·87
150	··	15	4·84	4·91	4·93
160	··	16	4·93	4·95	4·97
170	··	17	4·98	4·99	4·99
180	··	18	5·00	5·00	5·00

We see by this table, (although it is impossible, with any proportions or degrees of eccentricity, to work out a true ellipse by this method,) that we may approximate towards it sufficiently near for practical purposes, as Mr. Stephenson has done; while, on the other hand, without due precaution, we may so far deviate from it as to render the bar dangerously weak in the middle of its half-length.

As far as relates to ultimate strength, there can be no doubt Mr. Stephenson's rail is equal to that of an elliptic rail, and consequently to that of a rectangular rail of the same depth; but there is still an important defect in all elliptical bars, viz., that although this form gives a uniform strength throughout, it is by no means so stiff as a rectangular bar of a uniform depth, equal to that of the middle of the curved bar, and it is the stiffness rather than the strength that is of importance; for the dimensions of the rail must so far exceed those which are barely *strong enough*, as to put the consideration of ultimate strength quite out of the question. The object, therefore, with a given quantity of metal, is to obtain the form least affected by deflection; and unfortunately the elliptical bar, although equally as strong as the rectangular bar of the same depth, as far as regards its ultimate resistance, is much less stiff. This will appear from the following investigation.

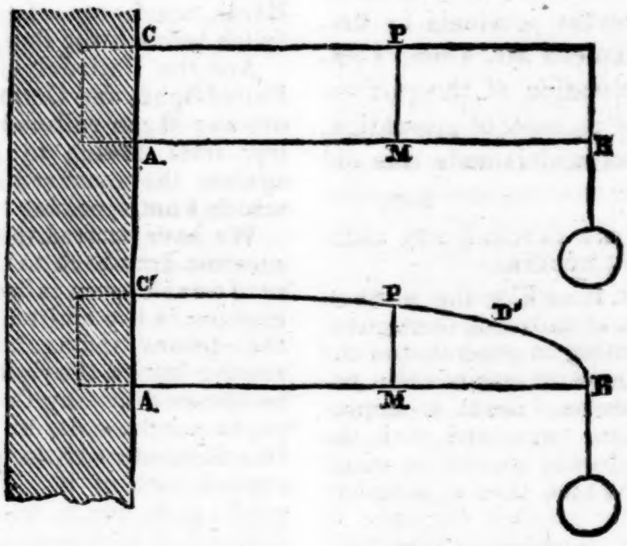


Fig. 1.

Fig. 2.

The deflections which beams sustain when supported at the ends and loaded in the middle, is the same, as the ends would be deflected, if the beams were sustained in the middle, and equally loaded at the ends, each with half the weight; and the *law* of deflection is the same in the latter case, as when the beam is fixed in a wall and loaded at its end, although the *amount* is greater. At present, however, our inquiry is not the actual, but the relative deflection in two beams, one elliptical, and the other rectangular, of the same length, and of the same extreme depth—the breadth and load being also equal in each. It is quite sufficient, therefore, to consider the corresponding effects on two half-beams, each fixed in an immovable mass, as representes in the preceding figures.

Now, in the first place, the elementary deflection at C is the same in both beams, because the lengths and loads are the same, and the depths at C A equal; but the whole deflection at any other point P, will be directly as M B^2, and inversely as M P^3. If, therefore, we call M $B=x$, and M $P=y$, the sum of all the deflections in the two beams will be $\int \frac{x^2}{y^3}. \, d \, x \; \triangle$, $\triangle$ being the sine of deflection at C. But in fig. 1, y is constant and equal to d, (the depth,) while in the latter,

$$y=\frac{d}{l}\sqrt{(2\,lx-x^2)}$$

l being the semi-transverse or length, and x any variable distance.

The whole deflections, therefore, in the two cases, are,

Fig. 1:—

$$\text{Deflection} = \frac{x^2\,dx}{d^3}\triangle = (\text{when } x=l)$$

$$\frac{1}{3}\frac{l^3}{d^3}\triangle$$

And in fig. 2:—

$$\text{Deflection} = \int\frac{x^2\,dx\,\triangle}{\frac{d^3}{l^3}(2\,lx-x^2)^{\frac{3}{2}}} = (\text{when } x=l)$$

$$\cdot 41\,\frac{l^3}{d^3}\triangle$$

The deflections, therefore, in the two cases are, with the same weights, as 33 to 41,* or nearly as 3 to 4, a result fully borne out by subsequent experiment. It is to be observed, also, that this investigation applies only to the deflection when the weight is in the middle of the bar, and that it would be much greater in comparison with the parallel rail towards the middle of its half-length. (*To be continued.*)

The following notice, from the U. States (Phila.) Gazette, of Mr. Young's apparatus for preventing fire from locomotive engines, is well worthy of attention. It is very important that measures should be adopted on *all* railroads to prevent accidents by fire. We earnestly recommend Mr. Young's improvement to the attention of those interested in railroads—" an *ounce* of prevention, &c." Every person understands this old adage.

YOUNG'S PATENT SPARK CATCHER FOR LOCOMOTIVE ENGINES.

Mr. Editor: At a time like the present, when the extension of railroads throughout our country is becoming so general, and the employment of locomotive engines has become a matter of course, I deem it important that all persons connected with the management of railroads should be made acquainted with the fact, that a complete remedy exists for the greatest nuisance to which this mode of travelling is liable, viz: the emission of sparks from the engine. That remedy is to be found in the contrivance with the name of which this article is headed, and the patentee is prepared to dispose of the right of using it, either at a reasonable rate for each engine, or at a gross sum, to be paid for the privilege by each company that may be desirous of availing itself of his invention.

It is now upwards of two years since the Spark Catcher of Mr. Young† has been in use on the New-Castle and Frenchtown railroad, since which period no instance has occurred on that road of a single garment having had a hole burnt in it by a spark from a locomotive engine. Of the tens of thousands of persons who have travelled the New-Castle road during the period named, not one can be found to gainsay the above statement.

Is there a single person, who has travelled on any other road in the United States, on which locomotives are used, with wood for fuel, that has not been annoyed, and either had his flesh or clothing burnt during his journey, by the means I have mentioned? I do not believe there is one to be found.

Is the Camden and Amboy road free from the intolerable and dangerous annoyance? No!—Baggage cars have been burnt, passenger cars have been on fire, and ladies almost denuded.

Is the great thoroughfare of Pennsylvania, the Columbia railroad, free from it? No! Barns, wood, crops of grain, and fences, have fallen beneath the flames in turn.

Are the Philadelphia and Trenton, the Philadelphia and Germantown,—in a word, are any of our railroads in the whole country, from Maine to Louisiana, provided against the inconvenience and danger of which I am speaking? No! not one.

We have arrived then at this point; the greatest drawback to the pleasure and safety of travelling on railroads with locomotive engines, is fire emitted from the chimnies of the engines, and against this a perfect preventive exists, the right to use which may be obtained by any Company that see proper to purchase it, at a reasonable price. One Company only in the United States has availed itself of it. The question for the public to decide is, whether they will suffer this sort of carelessness or false economy to prevail in Railroad Boards any longer, and allow their own property and lives, and those of their wives and children, to be jeoparded, or whether they will resolve with one accord to prosecute in all cases of damage the Company that undertakes to convey them safely without taking the proper precautions to do so.

The writer of this article is as ardently attached to the railroad system as any man in the country. He has long looked on the monstrous abuse, he is now noticing, in silence, but a solemn sense of duty, quickened by a recent signal illustration of the danger to which life is subjected by neglect in guarding against the particular evil of fire, has at length urged him to break his silence.

And I hope that this brief notice may induce a general attention to the subject, which is one, in my humble judgment, of paramount importance both to the corporations alluded to, and the public.

One word more. The assertion is distinctly made, and all contradiction of it defied, that Young's Spark Catchers are a perfect preventive to the emission of sparks

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* Experiments have been made from which it has appeared that the fish-bellied rail was stiffer than the parallel rail, which is certainly possible, if the parallel rail be of inferior metal or of injudicious figure; but it is mechanically impossible if the parallel bar be made of the figure here assumed.

† Mr. Young is the Engineer of locomotive power on the New-Castle and Frenchtown road, and resides at New-Castle.

from the chimnies of locomotive engines when in use. I believe it might be asserted with equal safety, that no other contrivance has been found to answer at all. L.

June 16th.

[From the Edinburgh Quart'y Journal of Agriculture.]

On an Improved Method of Mounting the Cradle-Scythe.—So far as I recollect, the Rev. Mr. Farquharson, of Alford, stated, in his former communication to the Highland Society on scythe-reaping, that latterly no appendage whatever was used on the scythe, in his neighborhood, for assisting in carrying round the cut corn to the swathe; and that scythe-reaping had been brought to its present pitch of perfection by laying all that sort of thing aside, and using nothing but the common hay scythe. In his last paper, however, he seems to admit the necessity of using a bow, except when the crop is much lodged; but even in that case I am clearly of opinion that some appendage on the scythe is indispensably necessary, and certainly would prefer a small rake to any thing I have yet seen. I have now had another year's experience of the cradle-scythe,* and have no hesitation in saying that it is the most efficient implement of the kind that I know of. Its superiority to the "long curved handle" consists, as I formerly stated, in the comparative ease with which it is wrought, which every person who has used it, and with whom I have talked on the subject, readily admits. I do not say that an experienced mower will not make sufficiently good work with a scythe fixed to the long curved handle, provided a rake be attached to it; but let any one compare such and the cradle-scythe at work together, and he will be at no loss to discover the preferable implement. Before the introduction of the cradle-scythe, the scytheman used to complain a good deal, for some days at the commencement of harvest, of *sore sides;* but no such complaints are now heard of. This is easily accounted for: Before the cut corn can be laid nearly square to the uncut with the long curved or common handle, the mower's left hand requires to go at every sweep considerably farther round to the left than with the cradle-scythe, owing to the position of the handles on the sned; and this, of course, occasions a corresponding turn of his body in that direction, which must be very sensibly felt.

The rake can be made very light; in fact, very little, if any thing, heavier than a bow, and the expense of either is trifling. I find that one bar about $\frac{3}{4}$ths of an inch thick quite sufficient to hold the teeth; and for all the cost I would recommend having rakes of various lengths, of from ten to thirteen or fourteen inches. For one of the shortest size, three teeth are commonly used, but I think they are no worse of four; and experience has taught me that much shorter teeth than those generally in use answer equally as well, and are much more easily disentangled of the cut corn. The teeth should be curved a little, like the blade of the scythe. Last harvest, a friend of mine suggested it as an improvement to have rakes of a circular form, and made so as to move out and in on a hinge at the lower end, in order to suit the different inclinations of the crop. Coinciding in his opinion, I got some of them made for a trial, and have the satisfaction to say, answered remarkably well. The head of the rake is eleven inches in length, and is curved to form a segment of a circle of about one foot four inches radius. The uppermost teeth are from five and a half to six inches long, and each of the three lowermost extends an inch beyond the one immediately above it. Instead of the rake being fastened to the heel of the scythe, as mentioned in my last letter, a piece of iron with two upright plates is clinked to the back of the scythe, about an inch from the back end of the blade. The rake is inserted between these upright plates, as in a socket, and a round nail with screw and nut is passed through them to keep the rake in its socket. By this contrivance, the rake can move backwards or forwards on the round nail as occasion requires. It is held steady, in whatever position it is placed, as follows: The small iron rod that connects it with the left handle of the frame is made thin at the end, and has seven or eight holes in it about $\frac{3}{8}$ths of an inch asunder. This part of it is bent so as to correspond with the limb or plane of the handle, to which it is held fast with a nail and thumb-screw, and by which it is readily shifted. The nail is put through the handle, from the lower side, six inches above where the handles unite. When

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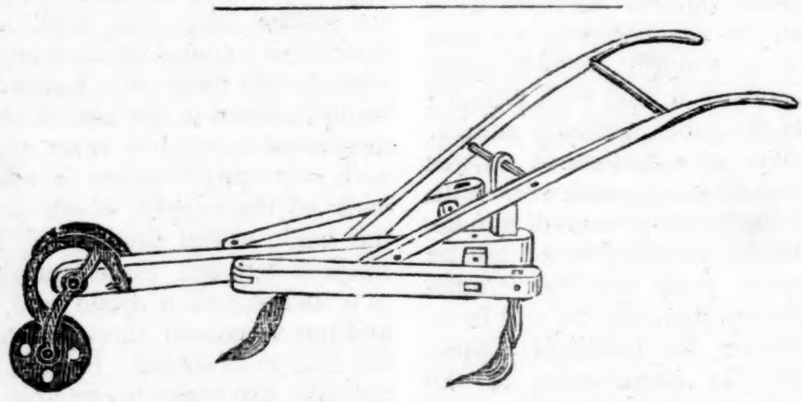
* Cradle, a frame for a scythe.—[Bailey's Diction'y.]

the corn stands upright, there is no difference in the position of the rake to the blade and handle of the scythe from the straight rake, except that the former is placed on the back edge of the blade, and the latter fixed into an eye-headed wedge at the heel of it. Both stand perpendicular to the blade, and it is only when the corn lies away from the scythe that the position of the circular rake differs from that of the other. If the corn be lodged or partly laid over with wind at the time of mowing, the circular rake is set back at the top by shifting the holes in the end of the rod that holds it fast to the handle, so as to answer the lay of the corn; and it is in this respect that it has the advantage of the straight-headed rake.

Last year, part of my crop, both oats and barley, was a good deal lodged; indeed, some of the former, on soft mossy land, were laid flat and twisted in every direction. The operation of cutting was consequently more tedious; but all was performed with the scythe in good style, and at much less expense than it could otherwise have been done. In instances of this kind, I would humbly recommend to cut *in* instead of *out* of corn, as it is usually termed. I adopted this plan last season, and really think it a good one. At first the scythemen were averse to it, but in less than half a day they changed their opinion, and acknowledged it to be the best. I commenced with it in a field of pretty ripe potato oats, which were a good deal lodged, and the grain dropping off in the working; and it was soon discovered that there was less loss of grain, a much freer cut, fewer rakings, and a neater stubble, — circumstances of no small moment to the farmer. The corn can be laid round, as even, and nearly as square, the one way as the other; but cutting *in*, if the crop is thick, seems rather hardest for the uptaker, which is owing, in some measure, to the free working of the scythe on the right hand, which allows the operator to come more speed.

Now that that very important operation, scythe-reaping, has become common in many parts of the country, and is practised in various ways in different places, it occurs to me that it would be an object well worth the serious consideration of our agricultural societies to promote its improvement, by holding competitions, and awarding prizes to the most meritorious competitors, as in the case of ploughing matches.

I. F.



Bement's Improved, Triangular, Expanding Cultivator, or Horse Hoe. [Communicated for the New-York Farmer, and American Gardener's Magazine.]

The above drawing is taken from one made for Mr. Bement's own use, with only three shares or teeth, and made very light, to be drawn by a small pony. The usual size has three shares and two scarifiers. The shares are double pointed, having one point at the top and another at the bottom, and are attached to the stock by a small screw-bolt and nut in the middle, so that when one point breaks, or is worn out, by turning the other end down, a new point or share is presented. A larger or smaller share may also be attached to the stock as occasion may require. The shares may also be replaced by scarifiers.

By the peculiar construction of the clevis, the roller or wheel, and with it the beam, can be regulated to any height required; and by raising or towing the hook, the line of draught can be adjusted accordingly. The sides may also be set wider or narrower, to suit any occasion.

In putting in such grains as are proper to be ploughed in, as barley, oats and peas, the larger shares may be used. The shares can be replaced by scarifiers, which are useful for cleaning out quack and other troublesome weeds, as well as scarifying meadows, previous to a top dressing of manure.

This cultivator or horse hoe is, in proportion to its cost, perhaps as valuable an implement as can be had on a farm, serving, as it does, a variety of uses, and being in all cases light and convenient to use; and I should think by the number of orders Mr. B. is receiving, it is coming rapidly as well as deservedly into use.

Fair of the Mechanics' Institute of the City of New-York. — The following circular is cheerfully published with a view of calling attention to the subject.

Institute Rooms, City Hall,
New-York, July 1, 1835.

This institution was founded in 1830, and incorporated by an act of the Legislature, in 1833, and now enumerates about seven hundred members; and has for its object, the instruction of mechanics and others in all the useful branches of science and the arts, while the tenor and spirit of its construction prohibits the introduction of politics, religion, or irreligion.

The course of education in our common schools, which the young mechanic generally leaves for the workshop, enables him to acquire a knowledge of reading, writing, and the rules of common arithmetic: but beyond these branches it scarcely makes any pretensions: he therefore labors under a serious difficulty at the very commencement of his business, namely, that of being compelled to learn a set of dry and often uninteresting rules, without a previous acquaintance with the principles upon which they are founded. It was with the view of supplying this deficiency, as well as others hereafter to be mentioned, that the 'Mechanics' Institute of the City of New-York' was established. It was designed as a school for teaching the most useful branches of physical and chemical science, to prepare the mechanic to understand and appreciate the lectures of the college or university, and thus increase his knowledge, usefulness, and happiness. The institution is founded on the most liberal principles, and though intended especially for mechanics, is open to all who are disposed to avail themselves of its privileges. An initiation fee of two dollars and the same amount in annual dues secure admission to its lectures, and exhibitions, and also to the use of the library.

In accomplishing its designs, the Institute has established regular annual courses of lectures on a variety of subjects connected with improvements in the arts, but more especially on chemical and mechanical philosophy. It has also an excellent library, a reading room, museum of models, and a valuable collection of chemical and philosophical apparatus — all of which are appropriated for the benefit of its members. To increase still more the facilities for the acquisition of useful knowledge, the Institute has engaged a scientific gentleman, who, under the supervision of the Board of Directors, has charge of the entire property, and gives his personal attendance at the rooms, which are now kept open day and evening throughout the year.

The Institute Rooms, situated in the City Hall, and consisting of a lecture room, reading room, library, museum of models, apparatus, etc., are now opened daily for the uses of the members and for the inspection of the public, where all who feel an interest in the advancement of science and improvement in the arts, are most cordially invited to call and obtain for themselves more perfect information as to the character, objects, and history of this institution.

To extend still farther its usefulness, and to carry more fully into effect its designs, the Institute has come to the determination to establish an *Annual Fair*, where the results of the genius and industry of the mechanic can find a ready avenue to the public eye, and thus be known and appreciated.

It is not intended that the Fair shall be confined to the productions of our own city; but, on the contrary, it is hoped that its managers may have the gratification of enumerating amongst the articles for exhibition, the productions of mechanical genius from every city and town of the Union.

Under these considerations, the Managers appeal with confidence to the public, and particularly to all immediately interested in the improvement and perfecting of the mechanic arts, to support them in their praiseworthy object—the moral and intellectual elevation of the mechanic, both in his own estimation and in that of others.

It may be further stated, that the Fair will be solely conducted by mechanics, for their improvement and benefit, and that the funds arising from the proceeds will be appropriated for the advancement of the objects of the Institute; it relies, therefore, with the utmost confidence on a liberal patronage from the public generally, and more especially from mechanics.

The Fair will be opened on Tuesday morning, the 29th of September next, at Castle Garden, where all articles for exhibition must be brought on the day previous.

For more detailed information, address the Corresponding Secretary of the Mechanics' Institute, City Hall, New-York.

A circular to the mechanics will soon be issued, containing an account of the premiums to be awarded, and the regulations by which the Fair will be governed.

Committee of Arrangements:

Samuel Carter, John Bell, William Ballard, Jonas Humbert, Jr., Henry Durell, John W. Dodd, N. S. Hunt, George Bruce, John Thomes, William Stebbins, Peter Walters, Uzziah Wenman, L. D. Gale, S. S. Ward, William Belcher, William Partridge, Oliver White, G. L. Price, Sereno Newton, Thomas Godwin, J. S. Redfield, W. H. Hale, James Walters, Gabriel Furman, John N. Baur, Daniel A. Robertson, Henry Cunningham, Thomas Timpson, John Steele, Jr., Henry Ludwig, James McBeath, John Remick, G. D. Kashow, George Sullivan, Charles Belcher, John Wint, P. C. Cortelyou, Colin Lightbody, William Norris, Fitch Taylor, Adam Hall, Robert Smith, William Everdell, Alex. Masterton, L. D. Chapin, William Frisby, Walter L. DeGraw, L. Feuchtwanger, Augustus Campbell, Samuel Bailey.

Samuel Carter, Chairman.
L. D. Gale, Secretary.

By order of the Institute:

George Bruce, President.
Henry Cunningham, Secretary.

We have been furnished with the following circular, giving notice of the 'Eighth Anniversary Fair of the American Institute of the City of New-York;' which will, we doubt not, as heretofore, be well attended, and at which our citizens will as usual derive much pleasure.

The Managers have the satisfaction to state, that they have procured for the coming Fair, Niblo's spacious and convenient establishment, 576 Broadway.

Articles intended for competition for premiums, will be received at the Garden on Friday and Saturday, the 16th and 17th of October next.

On Monday forenoon, the 19th of October, the judges will examine the articles intended for premiums. Such as are for exhibition merely, may be brought at any time during the Fair.

On Monday, at 12 o'clock, the Garden and the Saloon will be opened to visiters, and continue open four days.

The preparations for this exhibition already brought to the knowledge of the Managers, satisfy them that the coming Anniversary will afford the most cheering proof of our rapid progress in the arts, by a more ample display of the extent and perfection of American skill and industry, than has ever before been exhibited in this city; as well in the household departments of industry, as in those of the workshops and the larger manufactories.

The objects of the American Institute, under its charter, are broad and multifarious, embracing agriculture, commerce, manufactures, and the arts, throughout the United States. Space has accordingly been provided, suitable for a great number of bulky productions, natural and artificial.

The exhausting effects of our importations of woollens, cottons, and silks, amounting to nearly thirty millions of dollars per annum, render their increased home production extremely desirable. With a view to this, the quantity of broad-cloths presented for competition for the first premium, will be required to be not less than fifty yards; and cassimeres not less than one hundred yards. And in the awarding of premiums on cotton and silk goods, some regard will also be had to the quantity.

Inventors of curious and useful machines are particularly invited to exhibit their operations. These moving evidences of mechanical genius impart life and entertainment to the scenes.

The Ladies at all our former Fairs have contributed largely to render interesting the display. The Managers rely in full confidence on their continued favors.

Patriotic individuals—friends of American industry, and distinguished characters in this and other states, — are invited to attend the exhibition, and give their accustomed countenance and support to an institution that has for so many years exerted its influence to stimulate industry, and establish on a durable basis the independence of our country.

Thaddeus B. Wakeman,
Martin E. Thompson,
Adoniram Chandler,
Jonathan Amory,
Andrew Williams,
James F. Kenny,
Joseph Torrey,
John Sampson,
Frederick H. Wolcott,
Joseph Titcomb,
Charles H. Hall,
Isaac Fryer,
Edward V. Price,
Managers.

[From Transactions of the Essex Agricultural Society.]

ON COLORING.

[Continued from page 21.]

Black.—To dye woollen goods black, perfectly and most durably black, they must first receive an indigo blue, as described in our first method, and be well scoured out afterwards. The mordant used in dying black is iron—sulphate of iron (copperas) is most generally used for wool. There are a great number of dye-stuffs, both native and imported, used in coloring black. Nutgalls are usually considered the best for this purpose, but Bancroft says, and we think correctly, that the bark of the red flowering maple (acer rubrum), so common in swamps in this county, gives "a more intense, pure, and perfect black, than even galls, or any other vegetable matter within our knowledge." Logwood is a useful addition, especially where the cloth has not received an indigo blue. It certainly improves the appearance of the black dye from galls and iron, by rendering it more intense, glossy, and soft. In fact, it seems that almost every coloring vegetable matter for which the fibres of wool have an affinity, adds something to the body of black, and lessens the hardness or harshness which iron gives to wool. Among other articles, therefore, which may be advantageously used in black dyes, are the barks of our common elm and alder, and several species of lichen, or mosses, which grow on rocks, and have long been in use among us for dyeing various cheap colors.

For best Black, on cloth previously colored blue with indigo, take dried maple bark 12 ounces, or 1 lb. of the fresh undried bark, logwood 6 ounces, elm bark 8 ounces, and boil them in two gallons of water for one hour. Take out the bark, immerse the cloth, and boil another hour. Then take 5 ounces of copperas, dissolve in 2 qts. of water, and add it slowly to the liquor in the boiler. The cloth should be kept continually turning in the boiling liquor for two hours. Take it out, cool it, and again soak it in boiling water, to which a small quantity of ox gall or fresh cow dung has been added, another hour. Rinse it out, and scour it well with hot water and hard soap.

Cloths not colored with indigo will take a good black if the quantity of logwood be increased, and the dippings alternately in the decoction of the bark, &c. be many times repeated.

Black on Silk.—The fibres of silk do not so readily receive the black dye as those of wool. What the woollen dyer effects by three or four dippings, the silk dyer scarcely obtains from twenty. As the affinity of the silk for the soluble part of the galls or maple bark is greater than with the iron, it is thought most advantageous to begin by boiling about one half as much in weight of the galls or bark as of the silk to be dyed, in a suitable quantity of water, for three or four hours. Let it settle, pour off the clear liquor, and macerate the silk in the same for twenty-four hours. Being dried and slightly rinsed, the silk is afterwards immersed in a solution of the sulphate of iron (copperas), moderately warmed, and kept therein twelve hours, after which it should be rinsed and immersed in a warm decoction of logwood for several hours, again immersed in the solution of iron, rinsed, again transferred to the decoction of bark, &c.; repeating these alternate immersions till the desired color shall have been produced. Iron, dissolved in vinegar, is still better than copperas. A black vat may be easily prepared for coloring silk, by immersing in vinegar old iron hoops, turnings of iron, or iron in small and thin pieces, to which may be added maple bark, the berries and bark of the sumach, oak bark, alder bark, &c. and left to undergo a gradual solution by the joint action of the acids and acerb vegetable matters. The longer the liquors are kept, the better. In some coloring establishments in Europe such vats have been kept for ages, being replenished from time to time by additions of the several ingredients above mentioned. By repeated dippings in black dyes, silk may be made to acquire nearly a fourth part more in weight than it possessed before its natural gum had been separated from it by the boiling with soap, a process to which all new silk should be subjected before it is colored. But the color produced by this excess of black is not so good as it is when no such excess has been employed. As soon, therefore, as the silk becomes sufficiently colored, judging by the eye, it should be rinsed out and passed through a bath containing at the rate of one pound of starch and half a pound of linseed oil, well mixed with six quarts of warm water.

Black, on Cotton.—Cotton may be colored black in the dyes above mentioned for wool and silk. A somewhat different management is however recommended by the best writers on the subject. One, who is considered good authority, recommends making a decoction by boiling the logwood, maple bark, &c. above directed, and pour the clear liquor into a tub. Fill another tub with a like quantity of lime water, and another with the copperas water, formed by dissolving two and a half ounces of copperas to each gallon of water, and while the decoction and lime water are nearly boiling hot, dip and turn the cloth for thirty minutes, take it out, wring and air it; then put it into the copperas water and turn it as usual

fifteen minutes ; wring and air it again, then dip it in the lime water five minutes, and let it be well washed. If the color does not become sufficiently dense, repeat the operations until the desired effect be obtained. Then dip it in the mixture of starch, oil and water, as directed for silk. Much benefit may also be expected from soaking it a short time, previous to its being oiled, in a mixture of ox gall and water. When the cloth has not been first dyed blue with indigo, more dippings and a stronger decoction of logwood will be necessary. In some great dyeing establishments the black vat, as directed above, is chiefly used for coloring cotton black, instead of the copperas water, and is doubtless preferable, when it can be readily obtained. The cloth should be first steeped in a decoction of nutgalls, or the barks above directed, and afterwards macerated and worked several times in the liquor of the black vat, drying it between each of the macerations, and finally, being well rinsed, it is to be dyed with a quantity of maple bark, galls, &c., to saturate the iron imbibed in the black vat. To soften the black so produced, the yarn, &c. is usually passed through a bath of starch and oil, well mixed and stirred, employing for this purpose at the rate of one ounce of oil for each pound of cloth, yarn, &c. This employment of linseed oil gives a soft, glossy appearance to the black dyed upon cotton and linen, renders the color more intense and durable, and is particularly important for sewing thread. But care must be taken not to withdraw the cotton from this mixture till by suitable management the oil has been equally applied to all parts of it.

Having given what we believe some of the best methods of dyeing the four simple colors, and incidentally mentioned some of their compounds, we now proceed to give directions for coloring several of those which are most frequently used, or which have been, or still are, most highly esteemed by mankind. Among these are the purple, once the most costly and valued of colors, worn only by princes and the most wealthy of mankind. The ancient color was produced by a liquor found in small quantities in one or more species of shell fishes. It is yielded by a species of the Buccinum, which resembles in form the garden snail. This liquor is found in a little white or yellowish bag, placed transversely in immediate contact with the shell, near the head of its inhabitant. It is nearly colorless, but when applied to linen, cotton, &c., and exposed to the rays of the sun, it will become green, blue, and finally a most durable purple. Perhaps this animal may be found on our coast, and be advantageously used for marking fancy work, &c. Josselyn, in his 'New-England Rarities Discovered,' says—"At Paschataway, a plantation about fifty leagues eastward of Boston, in a small cove, called Baker's Cove, they found this kind of muscle, which hath a purple vein, which being picked with a needle yieldeth a perfect purple or scarlet juice, dying linen so that no washing will wear it out. We mark our handkerchiefs and shirts with it." But purple, being a compound of red and blue, is more cheaply dyed by the following method. The cloth must be first colored blue, by either of the methods recommended in this essay. The saxon blue (second method) gives the brightest, but least durable color. It must then be boiled with alum and tartar, as directed for yellow, and afterwards dyed with cochineal, employing from half to two thirds of the quantity required for scarlet. Or, instead of using the alum and tartar, the murio-sulphate of tin, as directed for yellow and scarlet, may be used as a mordant, and a more brilliant purple thereby obtained. Silk, previously dyed blue, by the first method, being macerated in the murio-sulphate of tin, sufficiently diluted, may be made to receive a fine and lasting purple, or violet, according to the shade of blue previously communicated, by dyeing it with cochineal. Some varieties of purple and violet may be produced by substituting madder for cochineal, but, though lasting, they will be less beautiful. Brazil wood, Nicaragua wood, and in fact whatever will color red, will give, with indigo blue, purples, often lively and beautiful, but they have but little stability.

On Cotton. — Cotton, macerated in a decoction of galls or maple bark, employing about one pound of galls to six of cotton, then dried and afterwards soaked in a saturated solution of equal parts of alum and copperas, being again dried, rinsed, and dyed with its weight of madder, will obtain a fast color, which, by varying the proportion of alum and copperas, using more alum the lighter you want the shade, may be made to incline more or less to purple or violet.

Green. — Green is a compound of blue and yellow, and we have incidentally mentioned the method of producing it, while treating of those colors. With indigo and quercitron bark, every shade of green may be given to suit the fancy, following the directions already given. When greens are produced on blues dyed by our first method, the blue part of the color will be most permanent. But the reverse happens when the saxon blue is used. In dyeing silk green, it is thought best to apply the yellow first. Employing a little logwood and sul-

phate of iron (copperas) with the yellow and blue coloring matters, will change it to a bottle green.

On Cotton.—Cotton must be alumed, &c., as directed in coloring yellow. This may be done after it has received the blue by method first. Macerating in a strong decoction of sumach, should not be omitted in the process. There are many other compound colors, which may be more cheaply produced by a direct application of coloring matters by a single process. Of such we shall now briefly treat.

Cinnamon Color, &c. — A very lasting cinnamon color may be dyed on wool, silk, or cotton, with maple bark and alum.

Hemlock bark, with alum, produces on wool a lasting bright reddish brown, and on cotton a nankin color, which is less durable. With copperas, this bark produces drab and slate colors.

Butternut bark dyes on wool, without any addition, a durable tobacco brown. With alum it will be rendered brighter, and may be fixed on cotton. With copperas, or iron dissolved in vinegar, it communicates to wool, linen, and cotton, a strong and lasting black; with alum and copperas, various shades of brown and drab. The bark of several species of walnut gives, with alum, chesnut brown; with copperas, drabs, &c.

Galls. These are excrescences produced upon several species of oak by the gall-fly. Those in common use are imported, but our farmers would do well to try those found on their own oaks, peradventure they may therein discover another source of income, for unless their use should be superseded by maple bark, galls will always find a market. We have already spoken of their use in dyeing black. It only remains to notice the light cinnamon fawn color, which galls (like many other vegetables that produce black with iron) afford, particularly on cotton, with alum. Galls communicate a durable nankin color to cotton, after the latter has been macerated in milk, dried, soaked in alum, with one eighth its weight of lime, afterwards rinsed, dried, and steeped in a decoction of this vegetable.

The bark of the cherry tree, and that of the horse chesnut, possess the property of producing a greenish olive, with copperas; and chamomile flowers are said to dye wool a durable green, with sulphate of copper (blue vitriol.)

Preparation of Wool, &c. for Coloring.—To prepare wool for dyeing, it must be macerated in warm water, mixed with one fourth of stale urine, or in a tepid solution of soap, employing one pound, with a sufficient quantity of water, to every twenty pounds of wool.

Silk.—New silk is naturally covered with a kind of varnish, or gummy substance, and generally tinged of a yellow color. This must be removed by boiling it with soap and water for one hour and a half. It is sometimes necessary to whiten it still further by the fumes of sulphur, to fit it for lively colors. The sulphur which adheres to it after this operation must be removed by soaking and agitation in warm water.

The art of applying a variety of colors to the same cloth, cotton, linen or silk, topically, either by the printing block, types, or the pencil, may be interesting to some of our fair friends who add to their accomplishments in the mysteries of housewifery, skill in drawing, and a taste for those fine arts which contribute to the embellishment of their persons. We therefore subjoin a few directions for calico painting.

Calico Painting.—Let your cloth be prepared by being well bleached, washed, dried, smoothed, and spread on a table, or stretched on a frame, as may be most convenient. Then draw with the following preparation, the parts of the figure intended for yellow, green, or red. Alum, powdered, one ounce, sugar of lead half an ounce, warm water three ounces—mix them in a phial, and shake them often for three days; afterwards add one scruple of potash, and one scruple of powdered chalk, let it stand and settle. Then pour off the clear liquor, and thicken it with gum arabic sufficiently to prevent its spreading when applied to the cloth with the pencil; add a little powdered charcoal, if you please, to the mixture, to make the drawings more visible. Let it then be thoroughly dried by a fire, heating it as much as can be safely done without scorching it. Then draw, with the following, the parts of the figure intended to be black. Take iron filings, turnings, small nails, or iron otherwise divided into small pieces, and put them into vinegar, with maple bark, or galls, sumach berries, and a little logwood—let them digest till it forms a very black ink. Mix with this ink gum arabic, till it is sufficiently thickened, and apply it wherever black is wanted, be it on the alumed parts, or on those before untouched by that mordant. Dry it by the fire as before. Do you want blue or green: Take indigo one ounce, potash one ounce and a half, quick lime half an ounce, brown sugar three ounces, and boil them in three gills of water, till the mixture loses its blue color and becomes green or yellow, with a copper-colored or blue scum. Keep it in a well stopped bottle, and when wanted for use, pour out a little in a tea cup or wine glass, and drop slowly into it muriatic acid till it cease to effervesce. Then, if it be not sufficiently thickened by the sugar, add

gum arabic, and apply it to the parts of the alumed figure which you intend for green, and to parts not alumed, intended to be made blue. Dry again, as before. If a dark olive be preferred to a black, or desired as an additional color, dissolve half an ounce of copperas in three ounces of water, and thicken it with gum arabic, and let it be applied to such parts as you wish should assume this color. Sulphate of copper, (blue vitriol,) used in the same manner, will give an olive inclining to yellow. In like manner other mordants may be applied, and a great variety of colors produced, by subsequently immersing it in a decoction of one or more dye-stuffs, as directed below. The cloth must now be soaked in warm water, in which a little ox gall has been infused, and rinsed out, without rubbing, till the gum and loose particles of matter applied by the pencil are washed out. Let it be now immersed in a decoction of quercitron bark, as directed for a yellow dye, and afterwards dipped in a mixture of warm water and powdered chalk, or weak lime water, and it will be found that the parts alumed have become a bright yellow, the alumed parts to which the indigo was applied have become green, the indigo on other parts remaining blue, the black unchanged, other colors produced on those parts upon which other mordants have been applied, and the remainder of the cloth slightly stained with the bark, which, however, will be readily removed by washing with cold or warm water, or by boiling it with water mixed with bran, and then slightly bleaching it in the sun and air on the grass. If you wish an addition of red, it may be now applied to the white or yellow parts in the following manner. Take alum two scruples, sugar of lead one scruple, nitro-muriate or murio-sulphate of tin one scruple, cochineal two scruples, water three ounces—boil them together, thicken with gum arabic, and apply it with a pencil as suits your fancy; on the yellow it will produce a scarlet, and on the white crimson. If instead of using the quercitron bark, you dye the cloth with madder, or Nicaragua wood, the alumed parts will become red, the indigoed purple, &c.

The preceding essay has been carefully, though hastily, compiled from Bancroft's Philosophy of Permanent Colors, and several other treatises on coloring, of good authority. Many of the methods directed we have proved correct, by experiments of our own, and we confidently recommend them to all interested. If the directions given be carefully followed, we doubt not any of the above colors will be obtained in a good degree of perfection. Good dye stuffs, of the kinds mentioned, will be indispensable to success. To distinguish the true quercitron from the bark of other oaks which nearly resemble it, you will do well to soak a small piece of it either in your mouth or warm water, and dip it in the murio-sulphate or other solution of tin. If it be the right kind, it will instantly show the brilliant yellow which it gives to cloths.

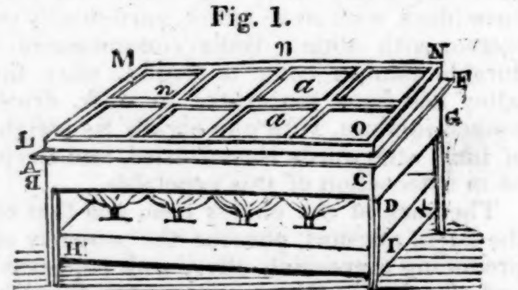
[From the Journal of the Franklin Institute.]

Experimental Illustrations of the Radiating and Absorbing Powers of Surfaces for Heat, of the Effects of Transparent Screens, of the Conducting Power of Solids, &c. By A. D. Bache, Professor of Natural Philosophy and Chemistry, University of Pennsylvania.

Among the very interesting phenomena of heat, there are many which are with difficulty brought under the eyes of a class, so as to render them satisfactory to each one by the test of sight. The thermometer, even when constructed on a large scale, affords but an inadequate means of rendering evident the temperature of bodies, to those who are distant from the lecture table, and the illustrations made by its use are, at best, rather tame. When the temperatures to be indicated admit of it, lecturers have, in preference to using the thermometer, resorted to the freezing of water, to the melting of wax, to the inflaming of phosphorus, the boiling of water, &c., as more adequate means of rendering evident the temperatures in question.

The instruments about to be described, I have found very convenient for class illustration, and always to afford satisfactory evidence of the positions to be proved. The first instrument is intended to show the powers of different surfaces in radiating and absorbing heat, with other phenomena, which will be referred to in the sequel.

Fig. 1.



To produce a sensibly uniform temperature, a prismatic vessel, A B C D F G, fig. 1, of sheet iron, of a convenient size, is filled with melted tin, and covered at top by a plate of sheet iron, A F, or, in preference, by a plate of cast iron, of moderate thickness. The temperature of the tin is

kept up by an alcohol lamp, H I K, with several wicks, fitting below the box, and between the legs which support it; by this means, the top radiates heat of considerable intensity. I prefer the use of tin, in the box, to that of oil, on account of the greater cleanliness resulting from its use, and because the oil gives off an offensive smell at high temperatures. Boiling water does not give a sufficiently high temperature to produce rapid action in the apparatus, and the greater exactness with which it would yield a constant temperature is not necessary in such an illustration.

A rectangular frame, L M N O, made of dry wood, to prevent its warping, of a small height, L A, and of a length and breadth such as to adapt it to its place upon the cover of the box, A G, is divided by cross pieces of wood into small squares, or rectangular compartments, as *n n*, the upper surface of the frame being perfectly plain, and parallel to the cover, A F, of the box containing the melted tin; this frame is intended to support, without the necessity of contact with each other, small plates of thin metal, or other appropriate material, the surfaces of which are variously coated.

To show the *radiating powers of different surfaces*, any convenient number of thin plates of sheet lead, or sheet tin, or mica, are cut to suit the size of the squares, *n n*, of the frame, overlapping the inner edges, but not extending to the middle of the small dividing bars of wood; each one of the plates has one of its surfaces differently coated; supposing them to be of lead, one is coated with lampblack, another brightened by sand paper, or coated with tin leaf, another left tarnished, a fourth coated with gold leaf. Being placed upon the frame, as at *a, a*, with the coated sides uppermost, small bits of phosphorus are placed upon the middle of the plates, and the frame put in its place upon the cover, A F. The surfaces which absorb the heat radiated by the cover, A F, being the same, the material and thickness of the plates being the same, the circumstances are alike in each plate, except so far as the upper surface is concerned; the plate which is coated with the worst radiator, will become warm first, and the phosphorus will melt first upon it, and, generally, the order of melting of the phosphorus will indicate the inverse order of the radiating powers of the surfaces. As the heat radiated from the cover is high, the melting of the phosphorus will be soon followed by its inflaming, and the order thus given will hardly deviate from the first; the interference from the film of oxide, which is so annoying in the modification of the apparatus of Ingenhousz, for illustrating the relative conducting powers of bodies, is almost entirely obtained by the high temperature of the source of heat. To avoid injuring the coated surfaces, a thin film of mica may be placed below the phosphorus, the film being large enough to prevent the effect of the spreading of the phosphorus, as it burns.

The plates should be made thin, in order that the results may be mainly dependent upon differences in the radiating power of the surfaces. I have used plates of thin sheet tin, (iron coated with tin,) of sheet zinc, and of glass, with good effect. The effects may be accelerated by coating the under surfaces with lampblack, to promote the absorption of heat; but in that case, care should be taken that the thickness is at least equal to that which produces the greatest amount of absorption.

Instead of the pieces of phosphorus, wax, or other readily fusible material, may be used, as in the apparatus of Ingenhousz; or cones of wood, weighted at the base, and kept upon the plate, with the vertex downward, by a fusible material, may be substituted.

It may happen that the lecture table is so arranged as to render it advantageous to incline the cover, A F, of the box, A G; this will be readily accomplished by making the cover part of the box itself, in which case the melted metal may be introduced through a hole in the higher side; as, for example, in A D.

To illustrate the fact that ***absorption and radiation are proportional***, the same square plates, *a a*, &c., may be used; the variously coated surfaces are placed downwards, phosphorus is put, as before, on the upper surfaces, and the frame deposited in its place upon the cover of the box. The phosphorus will now melt in the inverse of the order shown in the first experiment, the plate having the best absorbent surface heating first. If plates of metal be used, their upper surfaces should be bright, for this illustration; but glass, or mica, which will allow the coating to be seen through, is best adapted to the purpose.

The fact that the ***radiation***, or ***absorption***, of heat, ***does not take place merely at the surface***, but at a definite thickness, which becomes very appreciable in good radiators, may be satisfactorily shown by coating the surface of one of the plates with a thin layer of lampblack, and another one with a considerable thickness of the same material. If the coatings be upwards, as in the first illustration, the phosphorus will melt soonest upon the thinly coated plate; if the coatings be downwards, as in the second illustration, the reverse will be the case.

The ***effect of transparent screens*** in pre-

venting the passage through them of heat not accompanied by light, may be shown by using, in the same instrument, plates of glass, mica, &c., of equal thickness; theoretically, the differential results are not as free from objections as the former ones; but the fact is illustrated almost unexceptionably, since the phosphorus melts first at the surface of the plate, which it would not do if the plate were cool, and the fusion resulted from the absorption, by the phosphorus, of the heat which had passed through the screen of glass, or mica.

These illustrations I have tried repeatedly, and successfully; there are others of a more refined character, which I have not yet had an opportunity to attempt, but which, I doubt not, might be carried out very easily. The first of these is the curious property discovered in rock salt, by M. Melloni, of permitting the passage of heat of low intensity, as freely as that of high; a piece of phosphorus placed upon the salt, and another upon a thin film of mica, the under surface of which should be coated with lampblack, just above the plate of rock salt, would serve to show this property. That transparent plates of mica are only partially diathermous, would be shown in a similar way, and, in fact, by the relative periods of fusion of the phosphorus just above the plate, and of that upon it, a notion of the relative quantities of heat stopped and transmitted might be furnished.

Another illustration which I have tried with success, is that of the want of specific effect of color on the absorption of non-luminous heat: a fact which some researches, undertaken by Professor Courtenay and me, and not yet published, indicate. On coating the plates on one side with lampblack, plumbago, white lead, chalk, prussian blue, vermillion, &c., it will be found that the phosphorus melts upon them without regard to the order of color. Care should be taken that the thickness of the coatings is such as to give to them each the maximum radiating or absorbing power; a thickness which will differ for each material, but which may, for all, be very easily exceeded.

By a change in the character of the plates, this instrument may be used to advantage in showing the experiment devised by Franklin, and executed first by Ingenhousz, for indicating the relative *conducting powers of solids* for heat.

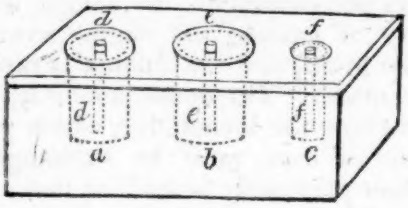
That the experiment just referred to does not truly give the relative conducting powers of bodies, can, I think, be clearly demonstrated, notwithstanding that it is found, in all the books, in juxtaposition with the very elegant and accurate method proposed by Fourier; with the explanation of its intrinsic defects, it may be, however, still admitted as a general illustration. To apply the instrument, plates of the same thickness of the substances to be tested, as, for example, of tin, iron, lead, copper, pottery, wood, glass, &c., which can be easily obtained in the requisite form, are to be coated on both sides with a thick coating of lampblack, or other good absorbent and radiator, leaving a small strip of the upper surface bare, to exhibit the nature of the material; the plates having phosphorus placed, on mica, upon them, are put upon the frame, and this is placed on the cover of the box: the order in which the phosphorus fires, gives the same indication as in the apparatus of Ingenhousz. This effect is more rapid than when cones, or rods, are used, especially from the lower temperature of the substance which is commonly used as a source of heat. These remarks do not apply, of course, to the forms of that apparatus in which hot sand is used.

The second instrument to be described is intended to show the common illustration of the fact that bodies have *different specific heats.*

Theoretically, this illustration is, I think, inaccurate, but is *admissible,* like the last; upon this subject, I hope to be able, at a future time, to be more explicit; at present, my remarks are confined to general illustrations. That different bodies require unequal quantities of heat to raise their temperatures through the same number of degrees, is illustrated upon equal weights, or bulks, by subjecting them, when at the same temperatures, to the same source of heat, and proving that they require different times to arrive at the same temperature. This idea is a fundamental one, and cannot too early be inculcated upon a learner. As an illustration, I have three vessels of sheet iron, to contain equal *weights* of mercury, alcohol, and water; these are fastened to a frame, by which they can be dipped into the same vessel containing hot water. An alcohol thermometer, with a column of fluid large enough to be visible at a moderate distance, dips into each vessel. As the heat enters, the thermometer in the mercury rises with great rapidity, that in the alcohol more slowly, and that in the water lags behind both the others. Instead of those thermometers, if a cylinder of any metal which is a good conductor, and has a low specific heat, such as copper, for example, should, after being coated with a varnish of thickened linseed oil to protect the surface, be introduced into each vessel, phosphorus placed on the top would melt and inflame first on the metal which dipped

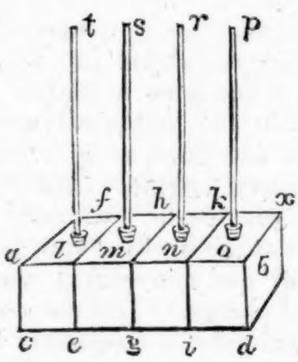
into the liquid having the least capacity for heat. In the annexed cut, fig. 2, *a*, *b*, and *c*, are the vessels; *d*, *e*, *f*, metallic cylinders resting in wooden, or metallic, or mica, disks, and the whole dipping into a vessel, *m n*, of boiling water. The mercury is so small in bulk, that the influence of this strikes the student immediately; but the idea which he thus catches at, is refuted by the more tardy heating of the water, which is less in bulk than the alcohol.

Fig. 2.



Before the forms of illustration, of the radiation and absorption of heat, already described, had suggested themselves, I had contrived another apparatus, which gave very good results, and may be, by some, preferred to the one already described. A long box, *a b c d x*, of tin, was divided into compartments by partitions, *e f*, *g h*, *i k*, &c., and a top soldered upon each, having

Fig. 3.

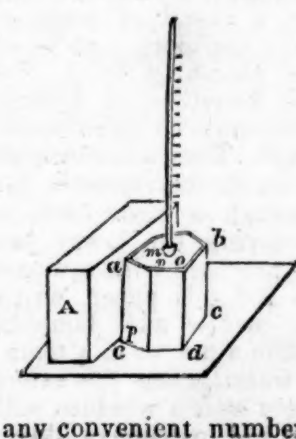


a conical opening, *l*, *m*, *n*, &c., to receive a cork, through which a tube, *o p*, *n r*, *m s*, *l t*, &c., passed; these compartments were made as nearly equal as possible, and the tubes entering them were selected of as nearly equal bore as possible; equal measures of colored water were poured through the conical openings into the several compartments, so as to cover the bottom to a depth regulated as will be presently stated. The tubes and corks were now inserted, and cemented; and each cell thus formed an air thermometer, the expansion of the air within driving the colored liquid up the tube entering the cell. That there might be no error from a want of equality in these thermometers, after bringing the liquid to a convenient height in each of the stems, by forcing air into each, or by dropping liquid from a dropping tube into the tube, the whole was plunged into a vessel of water, of a temperature sufficiently above the original temperature of the air within, to give distances on the tubes, readily divisible into equal parts of sufficient magnitude. These degrees were marked by a rude scale, formed by colored threads, tied around the tubes. One surface of the box was kept uniformly bright, or regularly tarnished, or coated; the other, *a d*, was coated with substances of different radiating powers.

The box being placed with the uncoated side towards a vessel of warm water, the heat enters uniformly that side of the compartments, but is radiated differently from the opposite side, and the liquid from the air thermometers is urged more rapidly up those tubes which enter into the compartments radiating worst, and ultimately arrives at a greater height, showing a greater stationary temperature, or temperature of equilibrium, between the heat absorbed and that which is radiated. If the vessel be now turned, so that the variously coated surfaces are towards the source of heat, the liquid in those coated with the best absorbents will immediately begin to rise in the tubes, and that in those coated with the worst absorbents, to fall. That the two lateral compartments are exposed to a greater cooling action than the others, may be an objection to this apparatus; but it is easily obviated, and with it the communication of heat from one compartment to another, by terminating the box at each end by a small compartment, and separating each of the other compartments of a similar space; in fact, convenience alone was the reason for uniting these air thermometers in one vessel.

Another form of apparatus, which is more simple, I have found convenient; but it occupies more time than that last described, in obtaining the same result. A

Fig. 4.



prism of any convenient number of sides, is made into an air thermometer, in the

manner described in speaking of the last apparatus; the sides are variously coated; it fits loosely into a prism of the same form, but wanting one side; in the figure, *a b c e*, represents the enveloping surface, and *m n o p*, the air thermometer. To show the different absorbing powers of the different substances, the vessels described are placd as in the figure, before another, A, containing hot water, hot sand, or any other convenient source of heat. Supposing the side of the air thermometer, which is the worst absorbent of heat, to be exposed to the source of heat, the air within is expanded, and the position of the liquid in the tube is marked by an index; a better absorbent is exposed, and the liquid rises higher; a worse, and it falls below its original level; the experiment can thus be varied at pleasure. The outer sheath, or covering prism, serves to render the surface, not exposed to the source of heat, uniform in its radiating powers, and to protect those sides which are not intended to be exposed to the source of heat, from the radiation of the vessel, A, which, otherwise, would affect them sensibly. If the air thermometer were a rectangular prism, of course the objection just stated would not apply; but the sheath would still be necessary to equalize the radiation from the surfaces not exposed to the source of heat.

To show the radiating powers of the different surfaces, the sheath is turned so that the open side is exposed to the air; the absorption of heat now becomes sensibly constant, and the greater or less height of the liquid in the tube is determined by the less or greater radiating power of the exposed surface.

The order in which the surfaces are exposed may, of course, be so arranged as not to require the temperature of the source of heat to be kept constant.

Such an apparatus, placed before a stove, would make an admirable illustration in a school; or a vessel of water, colder or warmer than the room, may be used as the radiating or absorbing body. For the tin vessel here described, a common square glass bottle may be substituted, without disadvantage. Even a common glass phial, made into an air thermometer by inserting a tube through a tight cork, into some liquid occupying the lower part of the phial, and provided with a moveable coating of tin foil, gilt paper, writing paper, and paper covered with lampblack, when placed before a fire, or in a room of which the air is warm, when the external air is cold, brought near a window, will afford an interesting and instructive illustration.

Philadelphia, February, 1835.

[From the American Railroad Journal.]

Remarks on the Substitution of Locks for Inclined Planes.

In my last communication on this subject, I stated that the extra cost of constructing the locks in question was more than counterbalanced by advantages not yet enumerated. One of these is found in the circumstance, that the locomotive moves continually with the train throughout the whole route. Where inclined planes are employed, the danger and difficulty of passing the engine over them are so great, that the attempt is rarely, if ever, made. The consequence is, that at each plane the locomotive, which propels a train of cars, must be exchanged for another previously heated, so that a much greater number must be kept in immediate preparation for use than though this necessity for change did not exist.

But the principal advantage to which I alluded as overbalancing the extra expense of constructing the locks in question, is the diminution of the expense of grading, which would result from their adoption. The annual expenditure of a stationary engine being so very great, and that expenditure being nearly the same, however inconsiderable the height to be ascended, it becomes a matter of great moment that the whole elevation should be made at one point so as to require but one stationary engine. But Nature, in moulding the earth, evidently did not fashion its surface with a view to the most economical and convenient construction of inclined planes. The ascent from low to high grounds is frequently extended, either gradually or by successive partial elevations, through a distance of miles. Under these circumstances, by means of deep excavations and high embankments, the ascent is concentrated into a short space, and is then overcome at once by means of an inclined plane and stationary power. This occasions an immense cost, the greater part of which might have been avoided by the use of locks. In this case there would have been no necessity of making the whole ascent at once. It is wholly immaterial whether the locks necessary for this purpose are placed contiguous, or at the distance of miles from each other. We can, therefore, accommodate our work much more nearly to the natural surface of the ground, and

thus each lock will probably save more than sufficient to defray the expense of its construction.

The recommendations of the locks in question, therefore, are: first, economy in the construction of the road by diminishing the expense of grading; secondly, economy in the operation of the road, by dispensing with stationary engines, by enabling the same locomotive to continue on through the entire route, and also to move a greater load, since the facilities of rising perpendicularly are rendered so great that it will be practicable to lay the rails more nearly horizontal than at present. These advantages would all be felt, though no difference were made in the direction of the route in consequence of the adoption of this system, and would abundantly recommend its introduction. But these are not all. The dread of engineers for every slight elevation being overcome by dispensing with the necessity of inclined planes, it will be readily perceived that the route of a railroad may be made much more direct than at present, and thus not only the expense of constructing many miles of road, but the cost and time of transportation over it, be curtailed; and, finally, the danger to which life and property are exposed in passing over inclined planes will be almost entirely annihilated.

The only objection of any validity which I have heard urged against the locks in question is, that they have never been tried. That caution, which serves as a barrier to the introduction of visionary schemes and unsubstantial novelties, is a most useful quality; but in the present case we seek to introduce nothing new, but only the application of known powers and principles in a new method and for a new purpose. The properties of the screw and the powers of a steam engine are both well tested and understood. If, by means of the former, a few men are able to raise the largest ships, can any one doubt that the same power, properly applied, would raise a few railroad cars of one half the weight? And if human strength can effect this, will there be any scepticism as to the efficacy of a steam engine in producing the same result? There is no room for doubt; there is no possibility of a failure. But to make assurance doubly sure, let us enter into a brief mathematical estimate. The proprietor of the screw-dock in this city has informed me, that fifty men are sufficient to man all the screws at once, and that they will easily elevate a ship weighing two hundred tons a height of two feet in the space of thirty minutes. Now, the engines employed on the Liverpool and Manchester railway are of 30 horse power. What ours are in general, I know not, but let us suppose them to be of 20 horse power. One horse is generally reckoned equivalent to six men. Suppose we say five, and the power of our engine will then be equivalent to that of 100 men; but when our engine is said to be of 20 horse power, the velocity of that power is supposed to be 20 miles per hour—call it fifteen—the velocity of human power does not exceed 2 miles per hour. The effect of a given power is proportional to its velocity, so that the power of 100 men, provided it moves at the rate of 15 miles per hour, is the same as that of 750 men moving only two miles per hour. The effective power of our steam engine is, therefore, 15 times as great as that employed in raising ships on the screw-dock. But the weight we shall wish to elevate will never exceed 100 tons, or one half the weight of a large ship. The proportion between our power and weight is, therefore, 30 times as great as in the case of the screw-dock. If, therefore, in the latter case, they can raise their weight 10 feet in 30 minutes, we shall be able to raise ours the same height in 1 minute, or 30 feet in 3 minutes. M.

[From the London Mechanics' Magazine.]

Substitute for Canal Locks.

Sir,—A short time since I read an extract from the Taunton Courier, (the date and particulars of which have escaped my memory,) which announced the opening of some branch canal in that part of the country, of about four miles in length; on which canal machines called "*lifts*," said to have been invented by Mr. Green, the engineer, have been introduced in lieu of the present mode of lockage. Now, if I mistake not, a similar machine was invented as many as twenty years ago, and actually brought into action by a person of the name of Woodhouse. But whether Green borrowed the idea from Woodhouse, or Woodhouse from Green, it is impossible for me to say. I

know it was considered at the time quite a new thing. However, it was found not to answer the intended purpose, being too complex, and too expensive for universal adoption. I should be highly gratified if some of your numerous correspondents would produce a drawing and description of one of these "*lifts*," for insertion in your journal; and I am sure there are hundreds besides myself who would be equally gratified.

If I might be allowed to state an opinion, I should say this mode is *inferior* to the old mode of *lockage*. Twenty or thirty tons is a weight which must require machinery of an immense strength and power to transport from one level to another, often differing from six to eight feet; and, as a natural consequence, the time lost must be considerable—much more, I should imagine, than by the present mode of *lockage*. To be sure, in short water seasons, like the last, they would be found highly valuable, as at such seasons loss of time is nothing compared with a saving of water. The past has been a trying season for canals, and the expense incurred by many of the companies has necessarily been very great. I have been told it has cost some of them as much as £3 *for every lock of water!* and that, too, for a *considerable length of time!*

I am, &c. J. L.

Bulbourne, March 23, 1835.

On Canal Navigation, by John Macneil, Esq.—We have been favored by a scientific gentleman of this city with a treatise on the subject of canal navigation, or the "*resistance of water to the passage of boats on canals,*" by John Macneill, Esq., Member of the Society of Civil Engineers, London, which gives a series of results that will appear incredible to those who are not familiar with great speed in canal navigation. There are many persons who will require further evidence before they will believe that navigation can be carried on on canals at the rate of 10 to 14 miles per hour, without injury to the banks, and that too on a canal narrower than the canals of this State; and many others who will hardly credit the theory, that the resistance will be less on a *narrow* than *broad* canal; yet such appears to be the opinion of those who have examined the subject, and experimented upon it. The following is the introduction of Mr. Macneill.

The results which I have arrived at by experiments are so much at variance with generally received theoretical deductions, that it is with much diffidence I submit these pages to the consideration of the public, and to those more immediately concerned in Inland Navigation. The following observations are made with a hope that those discrepancies between theory and practice may tend to a more rigid adherence to experimental inquiries in other branches of practical science, but especially, that they may lead to a more varied and extensive series of experiments to ascertain the best form of boats, not only at the cost of public companies, whose canal property may well demand it, but also at the expense of government, who lay out large sums in steam navigation; for I trust it is clearly shown, that very great alterations and improvements may be made in the models of all ships and boats which are not impelled by the wind, and that passengers and light goods may be carried by canals at a velocity hitherto supposed to be impracticable.

On the Resistance of Water to the Passage of Boats on Canals, &c.

The laws which regulate the resistance and impulse of fluids are involved in such obscurity, that candid investigators of this branch of science are compelled to confess that the dissertations of the physico-mathematician have failed in utility, and that even the deductions of the logician have been almost altogether ineffectual. The assumptions of the former, from which propositions have been deduced, and theories given out, are, at best, founded only on an hypothesis; the reasonings of the latter rest upon limited experience, and, in some cases, ill observed phenomena. And there is probably no branch of science which has so much engrossed the attention of the philosopher, and from which so little practical good has resulted.

That such is the fact, and that the farther the subject has been investigated, the more difficulties have been met with, if not always acknowledged, few can venture to deny.

If, in his zeal for information, the inquirer of the present day searches the shelves of philosophy, his labor will terminate in the settled conviction that this branch of science is but yet in its infancy, even although illustrated by the novel algebraical calculus, and the beautiful results derived from it by French ingenuity. A long course of patient experiment will alone warrant the adoption of formulæ; for as yet, as far as re-

gards the mere resistance of the fluid, the practical application of the laws founded by the mathematician has failed in producing any form which will rival the skiff of the Indian, the canoe of the Esquimaux, or the junk of the Chinese.

These observations apply to all boats and ships impelled by any other force than the wind; and this must not be forgotten, whilst we proceed to examine one particular department, viz. canal navigation. Every body moving in or upon the water, it will be seen, is under similar laws; and although the following results apply particularly to canal boats, they, nevertheless, are applicable to every other body which has to make its course by water.

The object immediately in view, when we place a boat or barge upon water, is a good conveyance for persons and property. So is it when we place a wheeled carriage upon a gravelled road, or a sledge upon snow. The difference, however, in the modes of attaining this object, has been most striking. In each of these cases, the body to be moved has been rested on soft or yielding matter, and whilst, in the two latter cases, no mechanician would provide for the wheels of the carriage, or the runners of the sledge, a facility for cutting along, immersed in the softer matter under them, the boat-builder seems to have studied how he could best keep his vessel ploughing her way. The case may be different with sea-going vessels, which are impelled by the action of a wind "on the beam," and ships of war, with their decks loaded with weighty guns; in such cases it is necessary that the vessel be a good deal immersed. Nor can it be satisfactorily shown, that even sea-going ships would not be improved by such a build as would enable them to rise to the surface of the water. But to pursue our *reductio ad absurdum*: there are many cases in navigation, where a sharp "cut-water" shape to a boat would be as unphilosophical as a knife-edged felloe would be to a wheel intended for ploughed land. A cart-wheel will, on gravel or other yielding matter, sink to the determined line of gravitation with as much certainty as will a boat upon water; and a boat resting in water will (according to the velocity given to it, and the form of its prow and bottom,) rise nearer the surface of the water, as well as a cart-wheel will rise when put rapidly into motion. The difference of density is, no doubt, much greater in one case than in the other; but the water will resist the penetration of the boat in the same manner, though not in the same degree, as the soft gravel or mould resists the wheel. Notwithstanding a conclusion so obvious to those who know the laws of gravitation, and the properties of matter, so easily calculated by every one who understands any thing of the combination of forces,* we find it has been neglected in order to determine what law regulates the movement of a body immersed to the same depth, at all velocities.

At a time when it was generally held, that the resistance to a vessel in the water increased in the duplicate ratio of the velocity of the vessel through the water, the now keenly contested merits of railway transport, and canal transport, were brought under public discussion. Experiments were instituted in order to confirm this law of resistance, but it occurred to none of the experimentalists that, although they could not increase the density of the water, or harden it, as has been done with roads for carriages, that they could still increase the relative resistance of water, by giving the boat such velocity that her prow could not penetrate fast enough, and thus that she should rise out of the fluid. They might have reasoned, by a perfectly fair analogy between conveyance on land or on snow, and conveyance on water, and have legitimately concluded that, as their object was not to cut through gravel, but to get on it, in the one case, so at high velocities, in the other, they should not have endeavored only to cut through the water, but also to raise the boat to the surface, and make her skim thereon.

Such facts are obvious to all, who have seen a boy make a thin stone skim the surface of a lake, — who have watched the action of a cannon ball on the smooth sea,—who have felt the difficulty of making any impression upon the stream forced from the small aperture of a fire-engine hose-pipe, — or, indeed, who know any thing of the properties of matter; but they had never been applied to the purposes of navigation, until it occurred to Mr. Houston, of Johnstone Castle, to try the effect of a light gig-shaped boat upon a canal; and it is very surprising that the most strenuous advocates for the adoption of such boats still reject the above facts, as irrelevant. It matters not whether the water be forced against the object, or the object be forced against the water.

In the month of June, 1830, Mr. Houston

* We find a good illustration of this resistance in "A Winter in Lapland and Sweden by Arthur de Capell Brooker, 1727," p. 338.—"The real superiority of the skielobere is chiefly shown when the enemy halt after a long march. Whatever precaution may then be taken, they are in constant danger from troops which have no occasion for path or road, and traverse with indifference marshes, lakes, rivers, and mountains. Even in those parts where the ice is too feeble to bear the weight of a man, the skielobere glides safely over, by the mere rapidity of his motion.

succeeded in having a light, long, and shallow wrought-iron canal boat established upon the Ardrossan canal, in Scotland, between Paisley and Glasgow. Since that period, such boats have continued to run regularly, conveying about sixty passengers a distance of "twelve miles, at a rate of eight miles an hour, stoppages included." Succeeding improvements in the construction of the boat, as well as in the mode of working the horses, enable us to state the above as a minimum of performance. In the Appendix, A, (page 94,) will be found a specification of one of such boats, and the annexed figure shows their form and dimensions. The following quotation from the advertisements, the truth of which is well authenticated, shows the cheap rate of conveyance.

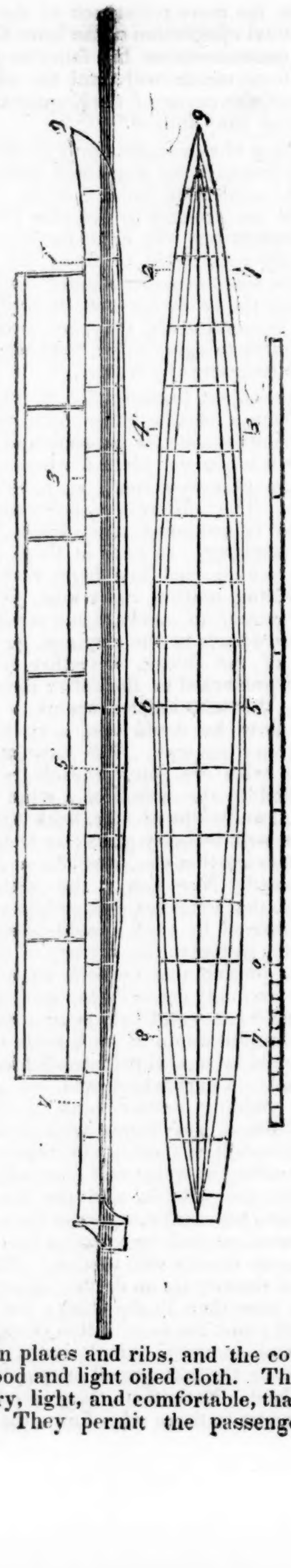
	Distance.	Cabin.	Steerage.
"Fare between Glasgow and Paisley..........	8 miles.	9*d.*	6*d.*
Fare between Glasgow and Johnstone............	12 "	12*d.*	9*d.*
Fare betweeen Paisley and Johnstone............	4 "	5*d.*	3*d.*

Intermediate distance as in the way-bill.

"The boats, at times, carry twelve hundred passengers in one day; and during eight months of last year, (1832,) notwithstanding the prevalence of cholera, they conveyed one hundred and twenty-six passengers, which is at the rate of fifteen thousand seven hundred and fifty, monthly."

Mr. Thomas Grahame, in his "Letter to Canal Proprietors and Traders," says, "The experiments of great velocity have been tried and proved *on the narrowest, shallowest, and most curved Canal in Scotland,* viz. the Ardrossan or Paisley Canal, connecting the city of Glasgow with the town of Paisley and village of Johnstone, a distance of twelve miles." The result has disproved every previous theory as to difficulty and expense of attaining great velocity on canals; and as to the danger or damage to the banks of canals by great velocity in moving vessels along them.

"The *ordinary speed* for the conveyance of passengers on the Ardrossan canal, has for nearly two years been *from nine to ten miles an hour,* and *although there are fourteen journeys along the canal per day, at this rapid speed, the banks of the canal have sustained no injury.* * * * * * The boats are formed seventy feet in length, about five feet six inches broad, and, but for the extreme narrowness of the canal, might be made broader. They carry easily from seventy to eighty passengers, and when required, can, and have carried, upwards of one hundred and ten passengers. The entire cost of a boat, and fittings up, is about £125. The hulls are formed of



light iron plates and ribs, and the covering is of wood and light oiled cloth. They are more airy, light, and comfortable, than any coach. They permit the passengers to

move about from the outer to the inner cabin, and the fares per mile are *one penny* in the *first*, and *three farthings* in the *second cabin*. The *passengers are all carried under cover*, having the privilege also of an uncovered space. These boats are drawn by two horses (the prices of which may be from £50 to £60 per pair) in stages of four miles in length, which are done in from twenty-two to twenty-five minutes, including stoppages to let out and take in passengers, each set of horses doing three or four stages alternately each day. In fact, the boats are drawn through this narrow and shallow canal at a velocity which many celebrated engineers *had demonstrated, and which the public believed to be impossible*."

Mr. Grahame then proceeds making apparent his want of confidence in railways—"The entire amount of the whole expenses of attendants and horses, and of running one of these boats four trips of twelve miles each (the length of the canal), or forty-eight miles daily, including interest on the capital, and twenty per cent. laid aside annually for replacement of the boats, or loss on the capital therein invested, and a considerable sum laid aside for accidents and replacement of the horses, is 700*l*. some odd shillings, or taking the number of working days to be three hundred and twelve annually, something under 2*l*. 4*s*. 3*d*. per day, or about 11*d*. per mile. The actual cost of carrying from eighty to one hundred persons, a distance of thirty miles, (the length of the Liverpool railway,) at a velocity of nearly ten miles an hour, on the Paisley Canal, one of the most curved, narrow, and shallow canals in Britain, is therefore just 1*l*. 7s. 6d. sterling. Such are the facts, and incredible as they may appear, they are facts which no one who inquires can possibly doubt."

The following is a statement I am enabled to publish showing the gross expense of running old heavy boats on the Paisley canal at the rate of four miles per hour, and new light boats on the same canal at the rate of ten miles per hour, and the comparative expense per mile; also the number of passengers carried before and after the introduction of the high and cheap speeds.

	Speed pr. hr.	Number of passengers carried.	Number of miles run each day.	Whole expense per year.	Cost pr mile; year taken at 312 days.
1830. . .	4	32831	48	700*l*. 4*s*. 7*d*.	11*d*.
1831. . .	10	79455	vary'g	1316*l*. 17*s*. 5*d*.	—
1832. . .	10	148516	152	218*l*. 5*s*. 11*d*.	10¾*d*.

NOTE.—The charges for the year 1830 are the bare outlays; and those for 1831 and 1832 include loss on purchase and sale of additional horses, and ten per cent. on cost of horses, boats; deposited in a contingent fund.

The power of conveyance thus established on the Paisley canal, may be judged of from the fact that on the 31st of December, 1832, and 31st of January, 1833, there were conveyed in these boats nearly 2,500 passengers.

The number of passengers continue to increase. The number carried in April, 1833, was twenty thousand, or at the rate of two hundred and forty thousand yearly.

It does, therefore, appear surprising, that canal owners in particular, whose property was daily becoming less valuable in the share market, by the alleged superiority of railway conveyances, should have been so blind or supine as to allow nearly three years to pass over, without making vigorous efforts to follow the successful example; but it is not the less true that they were, and indeed are still so; although, if the system be a good one, and practicable, and lucrative, as to me it appears undoubtedly to be, they could not have hit upon a more happy arrangement for keeping up their dividends, and for improving their property to a greater extent than it has arrived at, since the commencement of canal navigation in England. In many situations throughout the kingdom, where the quick transit of passengers, and even of light goods, was of consequence, it would not only enable the canal companies to compete with existing turnpike roads, but also to supersede the necessity for railways for general purposes.

We must suppose that canal proprietors did not credit the various reports in circulation as to the speed at which the boats were drawn upon the Paisley canal, the ease with which horses perform their work, and the small surge produced on the sides of the canal. But even supposing many of these reports to be exaggerated, and that false conclusions were come to by those who witnessed the performance, the great points of speed and economy were established to the satisfaction of many inquirers. Had the facts been known to canal proprietors, we should have expected the institution of a series of experiments long ere this, for ascertaining the actual resistance of boats at high velocities, and under every variety of circumstance, as well as the best form of boat suited to these velocities; the height of the wave or surge, as well as its character and effects, and many other important features, which were now for the first time exhibited.

It is most unaccountable why canal companies did nothing to determine such; and it is to be hoped they may now be induced to institute extensive experiments. The few experiments which are detailed in the following pages, though made with as much

accuracy as circumstances would admit, and though they are conclusive on some points, are by no means as extensive and varied as the importance of the subject demands. The scale of expenses was so exceedingly limited that they could not be carried farther, and others of still greater importance have not, in consequence, been undertaken, and remain yet to be made.

The energy and inquiring habits of Mr. Telford would not let such a practically useful inquiry remain dormant. He therefore directed me to make some preliminary experiments on a small scale, and to his liberality we are indebted for the first series, which were made entirely at his expense, in the National Gallery of Practical Science in Adelaide street; where the arrangements of the room were so admirable, and the accommodation, which the managers of the Gallery always gave for uninterrupted experiment during three weeks, was such,* that the most accurate results were obtained on a limited sheet of paper.

Figure 1 represents the plan and elevation of the reservoir of water in the National Gallery of Practical Science in Adelaide street, with the apparatus which was fitted up by Mr. Saxton, for the purpose of making the experiments. The straight part of the reservoir is seventy feet long, and four feet wide, with upright sides. The wheel and axle, B & *b*, were of excellent workmanship; the axle on which the weight acted was of hard wood, three and a half inches in diameter, and the wheel on which the line that pulled the boats was coiled was of brass, thirteen inches in diameter; the axis on which the wheel and axle turned was of polished steel, half an inch in diameter, working in brass. The pulley or sheave F, *f*, which was attached to the tin box or can, C & *c*, which held the weights, was of brass, two and a half inches in diameter, and its axis was of steel, with conical points working in brass. The line used for the weight was of catgut, one eighth of an inch in diameter, and the lines used for pulling the boats were, in some of the experiments, of silk, in others hemp, varying in thickness from one fortieth to one twentieth of an inch in diameter. The tension of the line in each experiment, or the force which was exerted on the boat by a given weight, placed in the bucket C & *c*, was not determined by calculations, but practically and accurately ascertained, not only by a spring dial placed on the line as at *f*, but also by an accurate beam and scales, furnished by Mr. Simms; by which means any mistake or inaccuracy in estimating the quantity of power was effectually prevented. The boat is seen at (*a*, *a*,) as she appeared in her passage from one end of the straight canal to the other; the moving power being the weight in the bucket (C & *c*.)

In making some preparatory experiments it was found that a considerable space was necessary to be passed over by the boats, from the point of starting, before they acquired a uniform velocity. It was therefore found necessary to limit the distance over which the uniform motion was measured, to a space of fifty feet, and consequently, great accuracy was necessary in determining the time of the boat's transit over so short a space. I therefore applied to my friends, Messrs. Arnold and Dent, the celebrated chronometer makers, in the Strand, who, with that liberality which usually accompanies science, not only furnished me with chronometers, but Mr. Dent himself, more than once, assisted in measuring the time, and comparing it with that observed by Mr. Turnbull and Mr. Bourns, whose accurate and careful observations have contributed so much to the success of these experiments.

Occasionally two, and sometimes three chronometers were used, placed as at (*h*, *h*,) on brackets, screwed to the side of the reservoir, at the commencement and at the end of the measured space.

Close to these chronometers, and exactly at fifty feet apart,* two brass wires were stretched across the reservoir, at eight inches above the surface of the water; by means of which wires the observers could determine the exact instant of time that the bow of the boat came under them, as they were slightly touched by a slender piece of brass wire, rising perpendicularly from the stem of the boat.

In some of the first experiments it was found extremely troublesome to ascertain the exact interval of time of the boats passing between the wires, in consequence of the chronometers having different rates of going; but this difficulty was obviated by a suggestion of Mr. Cubitt, who proposed that, after a certain number of experiments, the place of the chronometers should be changed, and the experiments repeated. This effectually obviated the difficulty, and enabled us to get the time with great precision. In the latter experiments, only one chronometer was used; it was placed on

* Every gentleman who witnessed the experiments, and saw the facilities with which the Committee and their manager, Mr. Payne, gave, agrees with me in bearing testimony to the liberal and philosophical spirit with which we were aided. They not only allowed a large portion of the gallery to be set apart, and put themselves to considerable inconvenience, but ordered the free admission of all persons interested or assisting in the experiments.

* In most of these experiments this distance was reduced to 30 feet, as shown in the "general plan."

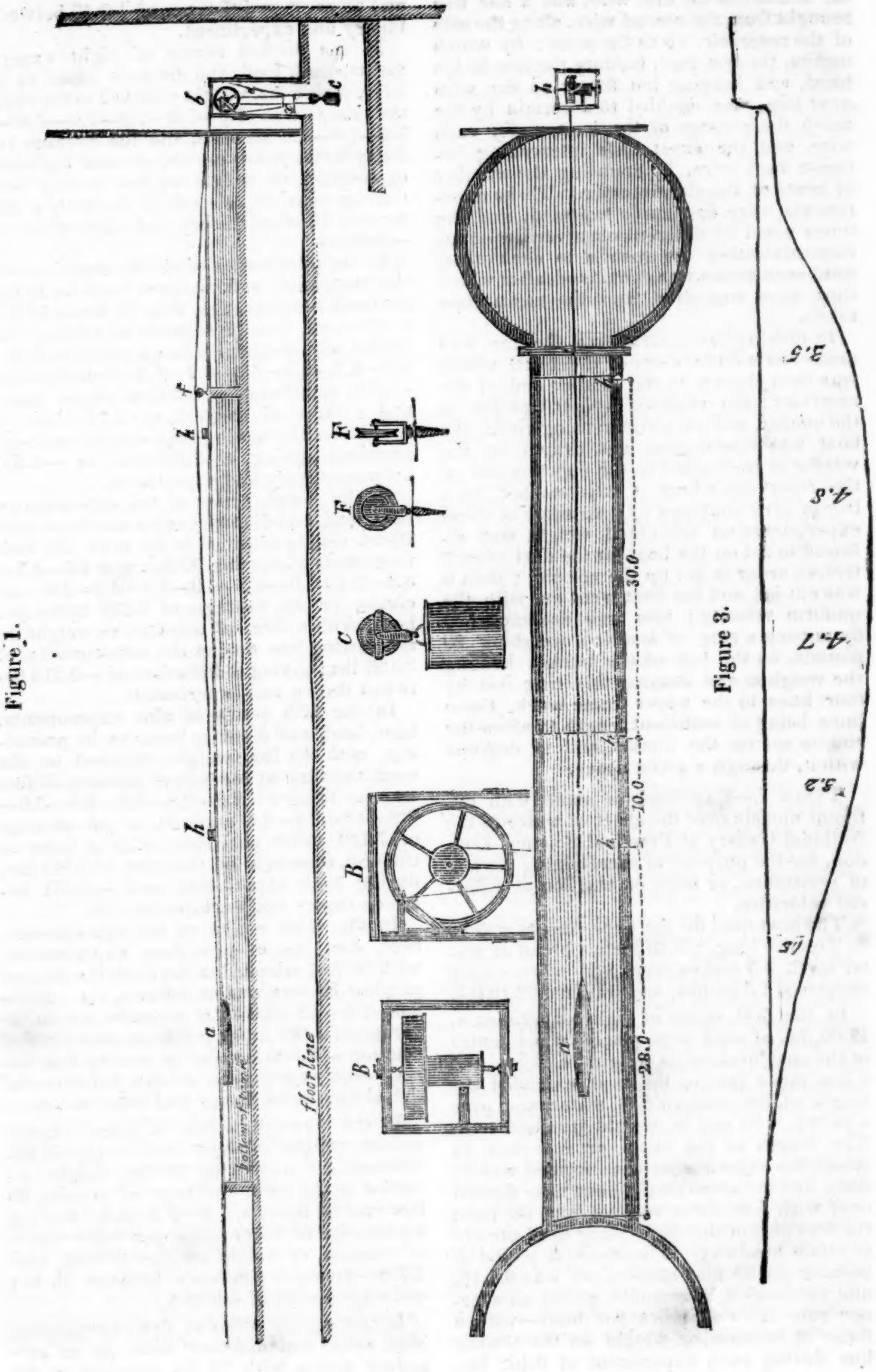


Figure 1.

Figure 3.

the bracket at the first wire, and a line was brought from the second wire, along the side of the reservoir, up to the point: by which means, the observer, holding the line in his hand, and keeping his finger on the wire next him, was enabled to ascertain by the touch the passage of the boat under each wire, and the exact time intervening between each wire, by counting the number of beats of the chronometer. These experiments were frequently repeated, and the times noted by different observers, without communicating the results to each other, until each series was completed, after which they were compared, and the mean time taken.

In making the experiments, the line was made fast to the stem of the boat, which was then drawn to the farther end of the reservoir; the required weight was put in the bucket, and on a signal being given, the boat was disengaged, and drawn by the weight in the bucket to the opposite end of the reservoir, where it was stopped by a bag of cork shavings (*f*). In some of these experiments an additional weight was allowed to act on the boat for the first twenty feet, in order to get up the velocity; then it was cut off, and the boat went on with the uniform velocity; this was accomplished by putting a ring of lead (*x*), weighing 20 pounds, on the top of the bucket holding the weights, and making this ring fast by four lines to the upper frame work, these lines being of sufficient length to allow the ring to act on the bucket, and to descend with it, through a given space.

TABLE I.—Experiments made with different models over the sheet of water in the National Gallery of Practical Science, London, for the purpose of ascertaining the law of resistance, or force of traction at different velocities.

The boat used for the experiments was 10 ft. 2 inches long, 8.5-10 inches broad at water level, 3.5 inches deep, and when empty immersed 1.5 inches, and weighed 22.19 lbs.

In the first series of eight experiments, 17.06 lbs. of shot were placed in the centre of the boat, making its weight 39.25 lbs., and a line made fast to the boat, extended the length of the reservoir of water, and over a pulley, with one lb. weight attached to it. The length of the canal or reservoir in which the experiments were formed was 70 feet; but the space marked out to be passed over with a uniform velocity was 30 feet; the first part of the space being used merely to attain headway. The shortest period of passing the 30 feet marked off was 9.4-10, and the longest 10 seconds, giving an average rate of 2.089 miles per hour—with a force of traction or weight on the towing line during each experiment of 0.468 lbs. and an average difference of +0.40 between theory and experiment.

In the second series of eight experiments, boat, load, and distance same as above, with 5 lbs. weight attached to the cord, the time was 7.0—7.0—7.0—7.0—7.20—7.4—7.0—7.0 seconds, and the average velocity 2.802 miles per hour—and the force of traction, or weight on the towing line, during each experiment, 1 lb., with a difference between theory and experiment of —0.102.

In the third series of eleven experiments, the boat, load, and distance same as in the first and second series, with 10 lbs. attached to the cord, time in seconds of passing the 30 feet with uniform velocity was 6.2—6.2—6.0—6.4—6.2—6.2—6.4—6.2—6.0—6.2—6.4—with an average of 3.290 miles per hour, and a force of traction of 1.718 lbs., or weight on the towing rope during each experiment, giving a difference of —0.556 between theory and experiment.

In the fourth series of ten experiments, boat, load, and distance same as above, with 20 lbs. weight attached to the cord, the time in seconds of passing 30 feet was 4.0—4.2—3.8—3.4—4.0—4.0—4.0—3.8—4.0—4.0 seconds, or an average of 5.232 miles per hour, with a force of traction, or weight on the towing line during the experiments, of 3.156 lbs., giving a difference of —0.216 between theory and experiment.

In the fifth series of nine experiments, boat, load, and distance same as in preceding, with 40 lbs. weight attached to the cord, the time in seconds of passing 30 feet was as follows: 2.8—2.8—3.0—2.8—3.0—2.8—2.8—2.8—2.8 seconds, or an average of 7.196 miles per hour, with a force of traction, or weight on the cord, of 5.812 lbs. during each experiment, and —0.251 between theory and experiment.

In the sixth series of six experiments, boat, &c., as in preceding experiments, with 60 lbs. attached to the cord, the time of passing 30 feet was as follows, viz.: 2.2—2.0—2.2—2.2—2.0—2.0 seconds, or an average of 9.607 miles per hour, and force of traction of 8.500 lbs. on the towing line during each experiment—with a difference of +1.412 between theory and experiment.

In the seventh series of three experiments, weight of boat and cargo 53.06, distance 30 feet, with 10 lbs. weight attached to the cord, the time of passing 30 feet was as follows, 7.0—7.2—6.8; making an average of 2.932 miles per hour—force of traction, or weight on the towing line 1.718—giving a difference between theory and experiment of —0.800.

In the eighth series of five experiments, boat, cargo and distance same as in preceding series, with 20 lbs. attached to the

towing line, the time of passing 30 feet was as follows: 5.4—5.2—5.4—5.4—5.2—making an average of 3.845 miles per hour, with a force of traction, or weight on the towing line, of 3.156; making a difference between theory and experiment of—1.568.

In the ninth series of eight experiments, the boat weighing 22.19 without load, the distance passed over, and weight attached to towing line, same as in the preceding, time of passing 30 feet was as follows, viz.: 3.0—3.0—2.9—3.2—3.1—3.2—3.0—3.2—at an average rate of 6.660 miles per hour, with a force of traction, or weight on the towing line during each experiment, of 3.156; making a difference between theory and experiment of + 1.608.

In the tenth series of four experiments, or from the 69th to the 72d, the boat, distance, space, and weight attached to the rope, same as in preceding, the time of passing over 30 feet was as follows, viz.: 3.0—3.0—3.1—3.0—at an average rate of 6.763 per hour, with a force of traction, or weight on the towing line, of 3.156; making a difference between theory and actual experiment of + 1.756. In this series, an additional 10 lbs. weight was added for the first 30 feet of the canal, to bring the boat to her full speed, before reaching the measured space of 30 feet.

In the eleventh series of seven experiments, or 73 to 79 inclusive, the boat, load, and space passed over, same as in the first series, with a weight of 20 lbs. attached to the line, the time of passing 30 feet was as follows, viz.: 3.4—3.6—3.8—3.4—3.6—3.6—3.8—at an average rate of 5.691 per hour, with a force of traction, or weight on the rope, during each experiment, of 3.156, giving a difference between theory and experiment of +0.322. In this series an accelerating force of 10 lbs. was added during the first 20 feet of the canal.

In the twelfth series, or from 80 to 82 inclusive, boat, load, space and power, (except the 10 lbs. additional,) as in the preceding, time as follows: 3.8—4.0—3.6—with an average of 5.392 per hour, and a power of traction of 3.156, and a difference of —0.034 between theory and experiment.

In the thirteenth series, from 83 to 87 inclusive, boat, load, and space, same as in preceding, with 40 lbs. weight, (and 10 lbs. additional to 86 and 87,) the time in passing the thirty feet was as follows, viz.: 2.8—2.7—2.7—2.7—2.7—with an average speed of 7.521 miles per hour, force of traction of 5.812; making a difference between theory and experiment of + 0.263.

In the fourteenth series, or from 88 to 92 inclusive, boat, load, and space, same as in preceding, with 70 lbs. attached to the rope, the time of passing over the 30 feet was 1.9—1.9—1.8—1.6—2.0—with an average rate of 11.180 miles per hour, power of traction 9.863; making a difference between theory and experiment of +3.561.

In the fifteenth series, from 93 to 101 inclusive, boat and space same as in preceding, and in No. 1, with 80 lbs. attached to rope, the time of passing 30 feet was as follows: 1.9—1.8—1.8—1.8—1.8—1.6—1.6—1.6—1.6—or an average of 11.928 miles per hour, and a power of traction of 11.217, and a difference between theory and experiment of 4.063.

[For the subsequent experiments, see next page, where they are given in full as contained in the table, and not, as in the previous descriptions, in a condensed form.]

It will be observed in the above tables, that as the velocity was increased, the power did not require to be increased in any thing like the duplicate ratio, and that the difference shown in the above column, betwixt the theory of the duplicate ratio and the actual experiment, becomes greater as the velocity is increased. I select from these experiments the following as instances. They are not taken from the means, but from the *items* of the experiments themselves.

At a velocity per hour of

2.763	miles,	1.	lb. is	required,	or	.180	*more*	than the theory of the square.
5.382	"	3.156	"	"	"	.045	"	
5.382	"	3.156	"	"	"	.045	"	
10.765	"	9.863	"	"	"	2.583	*less*	
6.392	"	3.156	"	"	"	1.232	"	
12.784	"	11.217	"	"	"	6.335	"	

I call attention particularly to these individual experiments, in order that the wide deviation may be noticed, and serve to shake the confidence still entertained by the adherents of the old school, who cannot allow that a high velocity is attainable upon canals with economy—not that I consider the old law of the squares to be incorrectly stated. In so far as the boat remains immersed in the water to the same water line, that law may be correct; but that whenever the velocity of the boat is increased beyond a certain point, as will be seen hereafter, the boat emerges a little out of the water, and skims nearer the surface,—the transverse section of immersion being lessened. This will be proved as we proceed.

Such facts being obtained and found to differ so widely from the opinions of philosophers, it was exceedingly desirable that they should not go forth to the public without the fullest confirmation. Happily for science, Colonel Page, Chairman of the Kennett and Avon Canal Company, to whose exertions and liberality it is entirely owing, induced the principal canal compa-

Number of Experiments.	Weight of Boat and Cargo.	Space passed over.	Time.	Miles per hour.	Moving Power.	Force of traction, or weight on the rope.	Force of traction calculated as squares of velocities.	Difference between theory & experiment.	GENERAL REMARKS.
	lbs.	*feet.*	*seconds.*	*miles.*	*lbs.*				
102	39.25	30	3.1	6.598	40	5.812	4.675	—1.137	One weight was placed in the centre of the boat; another weight 18 inches from the centre, abaft; and another 15 inches from the centre, forward.
103	"	"	3.0	6.818	"	"	4.992	—0.820	
104	"	"	2.7	7.575	"	"	6.162	+0.350	
105	"	"	3.6	5.681	20	3.156	3.466	+0.310	
106	"	"	3.8	5.382	20	"	3.111	—0.045	
107	"	"	3.6	5.681	"	"	3.466	—0.310	All the weights placed within 18 inches of the stern.
108	"	"	3.8	5.382	"	"	3.111	—0.045	
109	"	"	3.8	5.382	"	"	3.111	—0.045	
110	"	"	5.6	3.653	"	"	1.433	—1.723	
111	"	"	3.1	5.382	"	"	3.111	—0.045	Weights distributed as in No. 102.
112	"	"	3.8	5.532	"	"	3.111	+0.045	
113	"	"	3.9	5.245	"	"	2.954	—0.202	Weights placed 18 inches from stern.
114	"	"	3.9	5.245	"	"	2.954	—0.202	
115	"	"	2.0	10.227	60	8.500	11.233	+2.733	Weights as in No. 102.
116	"	"	2.0	10.227	60	"	11.233	+2.733	Weights placed 18 inches from stern.
117	"	"	2.0	10.227	60	"	11.233	+2.733	
118	"	"	1.5	13.636	80	11.217	19.970	+8.753	Grahame boat model.—Weight of boat alone 22.19 lbs.; length, 10 feet 2 in.; breadth at water line, 8.5 in.; depth, 3.5 in.; do., immersed when empty, 1.5 in. One weight 24 in. from the stern; a second weight 24 in. more forward; and a third 24 in. still more forward.
119	"	"	1.6	12.784	80	11.217	17.552	+6.335	
120	"	"	1.5	13.636	90	12.619	19.970	+8.351	
121	"	"	1.4	14.610	90	12.619	22.294	+10.305	
122	"	"	1.5	13.636	90	12.619	19.970	+7.351	
123	"	"	1.5	13.636	90	12.619	19.970	+7.351	
124	"	"	1.4	14.610	100	14.021	22.924	+8.903	
125	"	"	3.8	5.532	10	1.718			
126	"	"	4.0	5.113	10	1.718			
127	"	"	3.6	5.681	30	4.359			Bell boat model. Weight 9 lb. 13 oz.
128	"	"	3.0	6.818	50	7.265			
129	"	"	3.2	6.392	50	7.265			
130	"	"	3.6	5.681	50	7.265			
131	"	"	2.6	7.867	10	1.718			Ardrossan boat model. Weight 6 lb. 3 oz. Length 5 feet. Breadth at water line 4 in. Depth 1.5 in. Depth immersed 0.5 in.
132	"	"	2.8	7.305	10	1.718			
133	"	"	2.6	7.867	10	1.718			
134	"	"	1.8	11.363	20	3.156			
135	"	"	1.8	11.363	20	3.156			

nies in England* to subscribe towards paying the expenses of an extended course of experiments with a large boat. I accordingly proceeded to Scotland, and purchased one of the Paisley Canal Company's quick boats, the "Swallow," which we afterwards named the "Grahame and Houston," in compliment to the two gentlemen whc have been so eminently successful in improving the canal conveyance of Scotland. Indeed, Mr. Grahame's letters on the subject of canal navigation will furnish the most satisfactory reason why we should have used his name for the boat.

With this boat the results exhibited in the following tables (II. III. IV.) were obtained on the Paddington canal, opposite Holsden Green. The important effects which they are calculated to produce in the minds of the unprejudiced, not only upon inland navigation, but to nautical science in general, have determined me to publish them in the fullest manner, giving every particular connected with their arrangement, as well as the names of those scientific gentlemen who assisted me, together with the names of the assistants from my own office, so that the most ample evidence of accuracy and care may be had: for more advantage will be derived by accurate trains of experiments than will follow from the assumptions of a mathematical century.

The first requisite was a good dynamometer for measuring the tractive force necessary to move the boat at various velocities, and as I showed a marked preference for my own, with which I had obtained such important results during my surveys of roads for the parliamentary commissioners, I shall give a description of it, in order that readers may be satisfied such preference was justly given.

The dynamometer or pirameter, I originally intended for measuring the draught of carriages on turnpike roads, and for this purpose I have used it very extensively under the Parliamentary Commissioners, for the London and Holyhead road, and elsewhere. The following is a description

* The Grand Junction, the Kennett and Avon, the Aire and Calder, the Oxford, and the Leeds and Liverpool.

of the instrument, and in the appendix (B) will be found the opinions of competent judges upon its merits. When I at first endeavored to adapt Marriot's spring weighing machine, so as to ascertain from it the amount of the horse's draught, the stepping motion of the horse created a quick succession of vibrations, which completely prevented any one from reading off the figures indicated—and this confusion of vibrations will always prevent the simple adoption of any species of spring weighing machine. To remedy this inconvenience, and do away with the vibrations as much as was necessary, I applied a piston, working in a cylinder full of oil, and connected with the spring in such a manner that when any power or force is applied to it, so as to make the hand traverse the index, the piston is at the same time moved through the fluid. The connection of the spring and index with the cylinder is by means of a lever working on a pivot: the arms of the lever are of unequal length; the tail-piece of the spring and index is connected with the short arm; at the extremity of the long arm the piston rod is connected; the piston rod, after passing through a stuffing-box in the cap of the cylinder, is screwed into a piston or circular plate of thin brass, perforated with small holes; and out of one part of the circumference a square notch is cut, the use of which will be seen below.

By this construction, the resistance of the fluid to the piston, which acts at the extremity of the long arm of the lever, prevents the sudden jerks of the horse from being marked with those vibrations on the index so much to be avoided; at the same time the piston will move over a space proportioned to the intensity of the force exerted by the horse, and the same will be indicated accordingly upon the dial of the instrument; if the pulls follow each other in rapid succession, the piston will move slowly out, and the hand upon the index will turn round steadily and uniformly, until the power is balanced by the spring.

The dial is graduated in pounds, and decreases from zero upwards, in order to compensate for the increased force which the spring exerts in proportion as it is wound up; in consequence of this the index does not pass over equal spaces when equal forces are applied in different states of tension of the spring: the piston therefore will not pass through equal spaces in the cylinder, and the vibrations would consequently be greater in the higher numbers, because the velocity of the piston being less, the resistance to the piston in passing the fluid will be less, at the same time the power opposed to it is greater. To obviate this, and to make the index equally steady on all parts of the dial, a narrow slip of brass, formed into an inclined plane, is soldered to the inside of the cylinder, parallel to its axis, the largest (or highest) part of this inclined plane being at that end of the cylinder towards which the piston rises when the index moves towards the greater power. The notch which is said above to be cut in the circumference of the plate, (which traverses like a piston in this cylinder,) corresponds in size exactly with the largest part of this inclined plane; so that when the piston is at the upper end of the cylinder, the notch is completely filled up by the inclined plane; on the contrary, when the piston is at the lower end of the cylinder, the aperture is completely opened. By this contrivance the aperture through which the fluid is obliged to pass, as the piston moves from the lower end of the cylinder to the higher, is gradually contracted, and of course the resistance to the passage of the piston through the fluid is gradually increased, and thus compensates the increased power of the spring; rendering the vibrations nearly uniform from the lowest to the highest power. This compensation is similar to that by which the fusee regulates and gives uniform power to the main-spring of a watch.

This instrument* was placed in the doorway of the front cabin, (which is about fourteen feet from the stem of the boat,) and in a line with the ordinary tugging hook; secured with wooden braces and screw nails in such manner as to be perfectly firm and steady, in some instances the towing line was made fast to the weighing bar of the dynamometer, and the power communicated directly to it. In other cases the towing line was made fast to a shackle on an iron lever, the fulcrum of which was the screw bolt which made the bar fast to the gunwale of the boat on the bow nearest the towing path; the power being communicated from the lever to the dynamometer by means of another shackle; this last mentioned shackle being precisely twice the distance from the fulcrum. By this arrangement we were enabled to bring either the whole tractive force to be indicated on the dial plate at once, or only one half that power, as we please, by merely shifting from one position to the other.

I consider this arrangement to be advisable, lest by any chance there should have been an error in the graduation of the dy-

* In the modification of this instrument, which I have now mounted in a light double-bodied phæton, the dial plate is fitted, not only with an index and hand, but also with a card for determining the bearing; a pendulum which shows, by means of an index and hand, the inclination; a time-piece; and an index and hand to show the distance travelled by the wheels.

namometer. To prove its accuracy, we repeated most of the experiments with and without the lever. If when the power was communicated to the weighing bar of the dynamometer, the instrument indicated the whole traction to be one hundred pounds, and if, when the power was communicated to the other shackle, the instrument indicated only fifty pounds, we were warranted in concluding, that as far as this experiment was concerned, the dynamometer was accurate. Now this I had done on numerous occasions, to prevent the possibility of error; and in order to be more perfectly assured, I repeatedly employed weights, suspended over a pulley, to check the dynamometer.

In making the observations with the dynamometer, every care was taken to have accuracy. Mr. Whitwell kindly assisted me in all these observations. He took the time with an excellent watch, having a detached second hand, with a dead beat, which enabled him to give a signal very accurately at intervals of two seconds. At these signals the power of traction indicated by the dynamometer was read off silently and distinctly by two gentlemen, whose names are at the head of their respective copies. Each of these gentlemen added the observations together, and took the means of each set.

Whilst these observations were making at the fore sheets of the boat, the times of the boat's passage were noted a little farther aft, by Mr. Turnbull and Mr. Dundas, who had each an excellent chronometer (from Arnold and Dent's.) The word "*time*" was given by Mr. Wilson, when the boat passed the stakes which had previously been driven in the embankment at distances of one hundred yards apart. By this means the observers of the time had never occasion to lift their eyes from the chronometers, except to note down the observations.

Besides the gentlemen making these observations, I was always assisted by others; but more especially by Mr. Alexander Gordon and Mr. Saxton, both of whom being so well qualified, from their practical and scientific acquirements, for such a series of experiments, contributed very materially to prevent errors from taking place, by a general view over each department.

Fig. 3 (see page 87) represents a transverse section of the Paddington canal, opposite the village of Holsden Green; the soundings and measurements having been taken by Mr. Bourns and Mr. Turnbull.

[In the following experiments great care appears to have been taken to ensure accuracy; as the time of passing each stake, placed at 100 yards distance from each other, was marked by two first rate chronometers, and a full account of each is given, both the moment of passing each and the time between the stakes. It is not, however, deemed necessary here to give the separate statements of each time-piece—but merely the *mean* time of passing over the space of 100 yards between each stake, the velocity of passing, the mean force of traction as observed, and the weight of passengers in lbs., &c.]

Table II.—*Experiments made with the "Grahame and Houston" Iron Boat, on the Paddington Canal, for the purpose of ascertaining the law of resistance, or force of traction, at different degrees of Velocity. 8th April, 1833.*

No. of Experiments.	Mean time of passing over 100 yards between each Stake.	Velocity in miles per hour.	Mean Force of Traction in lbs., as observed.	Mean Force of Traction, calculated fm. the squares of the Velocities.	Mean Force of Traction, calculated fm. the cubes of the Velocities.	Weight of Passengers in lbs.	OBSERVATIONS.
	"	"					
11	42.25	4.841	75.				Wind ahead, but scarcely perceptible.
12	40.5	5.050	69.87				
13	40.0	5.113	66.50				
14	43.5	4.702	47.26				
15		4.955	61.21	97 90	192.58	2511	
16	37.5	5.454					
17	36.5	5.603	130.46				
18	36.75	5.565	150.11				
19	36.0	5.681	143.77				
20		5.616	141.44	125.94	280.38	2511	
21	29.0	7.053	140.53				
22	28.5	7.177	122.76				
23	27.5	7.437	119.67				
24	26.75	7.646	107.48				
25		7.420	116.63	219.09	646.68	2511	
26	27.0	7.575	170.87				
27	25.5	8.021	140.04				
28	25.0	8.181	136.98				
29	25.0	8.181	144.66				
30		8.127	140.56	262.83	849.71	2511	
31	21.75	9.404	226.28				
32	22.75	8.990	211.58				
33	23.0	8.893	183.40				
34	23.0	8.893	180.21				
35		8.925	191.73	314.80	1125.38	2511	
36	50.37	4.060	50.12				

TABLE II.—CONTINUED.

No. of Experiments.	Mean time of passing over 100 yards between each Stake.	Velocity in miles per hour.	Mean Force of Traction in lbs., as observed.	Mean Force of Traction, calculated fm the squares of the Velocities.	Mean Force of Traction, calculated fm the cubes of the Velocities.	Weight of Passengers in lbs.	OBSERVATIONS.
	"	"					
37	47.37	4.318	49.84				
38	47.5	4.306	42.59				
39	50.25	4.070	43.30				
40		4.231	45.24	71.24	119.89	2711	
41	23.0	8.893	235.07				
42	19.0	10.765	281.00				
43	18.0	11.363	303.47				
44	18.0	11.363	278.14				
		11.163	287.53	496.10	2202.02	2711	
45	19.75	10.356					
46	17.5	11.688	309.16				
47	18.5	11.056	311.39				
48	19.5	10.489	261.82				
49		11.077	294.12	488.83	2139.2	2711	
50	96.5	2.119					
51	91.0	2.247	23.45				
52	94.25	2.170	33.75				
53	92.25	2.217	23.3				
54		2.211	23.5	19.47	17.01	2711	Tracked by one man.
55	53.75	3.805					
56	57.25	3.572	47.28				
57	56.5	3.620	47.18				
58	56.0	3.652	45.04				
59		3.614	46.5	52.03	74.43	2711	By three men.
60	24.5	8.349					
61	23.5	8.704	174.97				
62	23.25	8.797	193.41				
63	23.25	8.797	174.18				
		8.766	180.85	306.14	1179.74	2711	By two horses.

In Table II., the first ten experiments are not published, because the arrangements were not, at that time, as perfect as could be wished. The length of the horse line was 82.1 feet; girth, 1.7-8ths; weight, 10 lbs. 1 oz. The length of the light line was 68.1 feet; girth, 7-8ths; weight, 2 lb. 8 oz. The standard adopted for calculating the squares and cubes of the velocities in the experiments mentioned in this table, and all those made on the Paddington Canal, was 2.517 miles per hour.

In Table III., experiments 5, 6, 7, 8, were made by a weight over a pulley; no accurate result. Experiments 13, 14, 15, 16, were also made by a weight over a pulley.

TABLE III.—*Experiments made with the "Grahame and Houston" Iron Boat, on the Paddington Canal, for the purpose of ascertaining the law of resistance, or force of traction, at different degrees of velocity. 9th April, 1833. Fifteen Passengers.*

No. of Experiments.	Mean time of passing over 100 yards between each Stake.	Velocity in miles per hour.	Mean Force of Traction in lbs., as observed.	Mean Force of Traction, calculated fm. the squares of the Velocities.	Mean Force of Traction, calculated fm. the cubes of the Velocities.	Weight of Passengers in lbs.	OBSERVATIONS.
	"	"					
1	73	2.801	29.73	–	–	2381	Tracked by one man.
2	77.25	2.647	26.21				
3	83.5	2.449	25.6				
4	83.25	2.456	23.9				
		2.517	25.24	25.24	25.24		
5	84	2.435	21 lbs.				
6	80.5	2.540					
7	76.5	2.673					
8	79.25	2.580					
		2.597	21	26.87	27.72	Weight the same throughout.	
9	68.25	2.977	35				Tracked by two men.
10	68.0	3.008	26.2				
11	63.25	3.233	33.8				
12	64.75	3.158	29.95				
		3.133	29.98	39.10	48.67		
13	67.5	3.030	33 lbs.				
14	69.0	2.964					
15	67.75	3.019					
16	73.25	2.791					
		2.924	30	34.06	39.57		
17	48.5	4.217	59.4				
18	48.0	4.261	56.62				
19	45.5	4.217	62.83				
20	44.0	4 648	65.5				
		4.375	61.65	76.25	132.55		
21	52.0	3.933	58 lbs. too little by 10.				Tracked by two horses.
22	45.5	4.495					
23	43.75	4.675					
24	41.25	4.622					
		4.597					
25	21.5	9.513	267.0				
26	21.25	9.625	238.52				
27	22.0	9.297	228.20				
28	21.75	9.404	231.48				
		9.442	232.73	355.18	1332.51		
29	16.5	12.396	436.94				
30	17.0	12.032	395.66 ?				

TABLE III.—CONTINUED.

No. of Experiments.	Mean time of passing over 100 yards between each Stake.	Velocity in miles per hour.	Mean Force of Traction in lbs., as observed.	Mean Force of Traction, calculated fm. the squares of the Velocities.	Mean Force of Traction, calculated fm. the cubes of the Velocities.	Weight of Passengers in lbs.	OBSERVATIONS.
	′	″					
31	19.5	10.489	300.26				Tracked by two horses, large line.
32	20.0	10.277	270.5				
		10.383	285.15	429.50	1771.93		
33	18.25	11.207	403.6				
34	19.12	10.697	344.8				
35	20.25	10.100	273.0				
36	22.0	9.297	245.75				
37		10.031	287.85	400.87	1597.77		
38	75.5	2.709	27.34				Boat tracked by two men
39	77.5	2.638	25.21				
40	81.0	2.525	22.01				
41	86.0	2.378	22.82				
42		2.513	23.34	25.16	25.12		
43	61.75	3.312	37.35				
44	64.5	3.171	32.36				
45	64.25	3.183	32.23				
46	65.0	3.146	30.15				
47		3.166	31.58	39.93	50.23		
48	17	12.032	350.9				One horse employed to track the boat.
49	17	12.032	337.75				
50	18.5	11.056	318.3				
51	20.5	9.977	276.55				
52		11.021	310.86	483.90	2119.05	2381	
53	26.25	7.792	189.5				
54	27.	7.575	148.7				
55	26.5	7.718	147.22				
56	26.0	7.867	148.85				
		7.72	148.26	237.44	728.33	..	
57	36.5	5.603	132.84				
58	38.25	5.347	135.26				
59	34.0	6.016	155.41				
60	38.25	5.347	154.52				
61		5.57	148.39	123.60	273.54	..	
62	26.25	7.792	199.07				
63	25.75	7.943	159.65				
64	26.75	7.646	149.2				
65	25.25	8.100	147.62				
		7.896	152.15	248.38	779.28	..	
66	33.75	6.060					
67	35.5	5.761	168.58	139.48	327.93	..	
68	33.5	6.105					
69	34.75	5.886					
70		5.917					

APPENDIX.

A.

Specification of a Light Iron Passage Boat, such as ply on the Summit Level of the Forth and Clyde Canal, between Port Dundas and Windford, and such as was used in the Experiments detailed in the foregoing paper.

Extreme length, 70 feet; do. breadth, $5\frac{1}{2}$ feet. The iron of the very best manufacture. The body plates in particular must be free from rust, cracks, blisters, and roughness of every description. The whole of the iron must be coated with linseed oil, previous to its being used. And the boat must be built under cover, so that the work may be kept dry until the boat is finished.

Although not shown on the plan, the said boat has a hollow keel, so as to prevent the lodgement of water beneath the floor, between the ribs. The stem and stern shall consist of bars of iron, six inches in breadth, and a quarter of an inch thick, which are hammered flat at the lower part to the breadth and thickness of the keel-plate, to which they are scarfed and secured with clenched rivets.

As stated above, the keel-plates are formed hollow, and consist of hoop iron, six inches in breadth, and one eighth of an inch in thickness. To which a wood keel of Memel plank, fifty feet in length, nine inches in depth, three inches in thickness next the bottom of the boat, and an inch and a half at the lower edge, tapered off to nothing at each end, must be secured to the keel-plates with glands an inch and a half in breadth, and a quarter of an inch thick, sunk flush into the keel, and screwed inside at the distance of three and a half inches apart.

The ribs shall consist of T and angle iron, and placed alternately at the distance of twelve inches from each other, and extending from gunwale to gunwale; after being bent to suit the curved form of the vessel, two rows of holes are punched on the flat side of the angle and T ribs to secure the body plates, and holes at convenient distances are punched through the upright flange to secure the false ribs for the inside lining.

The body-plates must consist of the best double rolled No. 16 sheet iron, two and a half lb. per superficial foot, and these sheets are in lengths of eight and ten feet. The first range of bottom plates which join the hollow keel, eight feet in length and 24 inches in breadth; the next two ranges on each side which form the bilge, ten feet in length, by twelve inches in breadth; and the range next gunwale, ten feet in length by eighteen inches in breadth. Particular attention is requisite, both with the view to the strength and appearance of the boat, that the whole of the body-plates be run in fair sheer lines

from stem to stern, and that the lower edge of each succeeding length or range of plates cover the upper edge of their accompanying ones, three quarters of an inch, so that the boat in every respect may have the appearance of being clencher built.

The butts, or end joints of the plates, must be kept smooth, and meet on the centre of the T rib, and the joints of each succeeding plate be so shifted as to meet on the T rib nearest the centre of its accompanying ones. It must, however, be expressly understood, that previous to any of the plates being rivetted, a thin stripe of cotton cloth, dipped in white lead paint, be put in between the overlaps of the edge joint, and between the ribs and the end joints, so as to prevent leakage and corrosion. The whole end and edge joints must be secured with countersunk rivets, made from a three-sixteenth of an inch bore, placed at the distance of three fourths of an inch from centre to centre, and made from the best charcoal rivet iron; the rivets, except those for securing the end joints, must be placed two inches distant from each other, and the whole, as stated above, be countersunk, and kept as smooth as possible.

Plates, six inches in breadth, and one eighth of an inch in thickness, to be placed on each side along the bilge, over the body plates, where they are most exposed to injury when taking on board and landing passengers, which will extend from the round of the entry, at the bow, to the commencement of the run or exit at the stern, and are secured to the ribs and body plates with countersunk rivets, placed at the distance of three inches apart; but before they are secured, both the bilge plates and body plates must be properly coated with white lead paint, and a ply of sheathing, dipped in the same, put in between.

One and a quarter inch of angle bars extend from stem to stern, to form the gunwale, to which welts or wood mouldings are secured; and another of the same dimensions to be placed seven inches below the gunwale, to which the wood-belting, three inches thick, and four inches deep round off, is to be secured.

The boat is framed and moulded, and in every respect formed, exactly and agreeably to the plan, and the work must be done in a substantial and workmanlike manner.

Specification of the Carpenter and Joiner Work of such a Light Iron Canal Passage Boat.

The length of the boat as specified, at seventy feet in length, five feet six inches in breadth, and two feet six inches in depth. It is divided in the following manner, viz. Fore deck, 4 feet in length; fore sheets, space for steerage cabin and principal cabin, &c., and after sheets, according to the number of the travellers intended for; after deck, 4 feet.

The false ribs for securing the inside lining consist of willow timber, one inch in breadth, and seven-eighths of an inch in deepness, which must be free from knots and shakes, so that they may bend easily after being stoved to the curved form of the boat, to which they are secured with nails, rivetted to the upright flange of the ribs.

The sea-crofts, fore and aft, must extend from the stem and stern to the end of the cabins, and be four inches in breadth, and two inches in thickness, of best Memel plank, which is kept flush with the gunwale inside, and secured with three-eighths of an inch rivets, one throughout each rib.

Two timber heads on each side, near the bow and stern, are placed in the most convenient situation for mooring the boat, and secured with glands fixed with clenched rivets, so that the timber heads may be taken out and replaced when found necessary; to consist of solid oak timber, five inches in breadth, two inches thick, one foot in length below the gunwale, and seven inches above.

The beams which support the deck fore and aft consist of oak plank two inches thick, three inches deep in the centre, and two inches deep at each end, with a curve of half an inch to the foot in length; and they are secured with a sheet-iron plate to the gunwale, angle iron, and sea-croft.

The gunwale or covering boards should consist of the best Memel fir plank, one inch in thickness, which extends from stem to stem; the cover is secured to the gunwale flange and wele that forms a moulding round the same.

The ends and divisions of the cabins should consist of Memel plank, two and a half inches in breadth, and one and three-fourths inch thick, which will form diagonal frames, for the purpose of strengthening the boat, so as to resist external pressures. The said frames must be lined at the ends of the cabins outside, with the best half-inch American yellow pine plank. The framing in the inside of the cabins may be lined as may be approved of.

The sleepers, for support of the flooring, should be two inches deep, by one and a quarter inch thick, placed and fitted to each alternate rib, and fixed to the upright flange with rivet nails. The flooring should consist of the best yellow pine plank, one inch thick, and not to exceed six inches in breadth, which must be properly cleaned, ploughed, and feathered.

The height of the cabins, from the top of the floor to the lower part of the beams, six

feet at the centre, and the height of the sides above the level of the floor will be five feet under the beams, consequently the beams will have a curve of twelve inches.

The standards or stancheons of the sides of the cabins should consist of the best white American oak, one inch thick, and one and a half broad at the gunwale, and one inch in breadth at the top of the cabin, and placed at each alternate rib, to which it is secured, the distance being twenty-four inches from centre to centre. The top gunwale, for the support of the roof, to be made of the best Memel fir or red pine, free of blemish or knots, and extend the whole length of the cabins, two and a half inches deep outsides; the upper edge is bevelled to suit the curve of the beams, and two inches in thickness, mortised to fit the tenure of the standard, having a projection for a bead, and thickness of outside lining.

The beams, as stated above, to have a curve of twelve inches, to consist of the best clean ash timber, an inch and a half in breadth, by one inch in depth, the lower part rounded to a half-circle, and placed at the distance of two feet from centre to centre, dove-tailed and secured to the gunwale with screw-nails; and a framing of iron wire gauze, well painted, shall be made to connect them, so that the top may form one solid connected form from end to end.

A stringer extends the whole length of the cabins in the centre to support the roof, which is let in, and bound to the diagonal frames, the upper edge kept flush with the top of the curve, consisting of clean solid white Quebec oak timber, three inches in depth, by an inch and a half thick; into which the beams are let nearly in the whole depth, and made exactly for the top covering.

The space outside of the cabin, fore and aft, must be lined from the floor to the gunwale with five-eighths of an inch red pine boards, and seated in the usual form; the tops seven-eighths of an inch thick, with round supports and cross bearers, with two front rails, two and a half inches in breadth, beaded, and let in flush with the bottom and top of the supports or feet.

In order that the boat may be kept as light as possible in the fittings-up, there should be no inside lining of wood from the floor up, consequently the whole seatings in the cabins must have fronts supported with brackets; these brackets to be secured to a stringer, fixed to the sides of the boat the whole lengths of the cabin, three inches in breadth, by an inch and a quarter thick, to which the brackets are let in flush, and nailed to it and the floor. The seats in the principal cabin to be sixteen inches in height, so as to allow cushions two inches thick and eighteen inches in breadth; the back to be one inch lower than the front, which is considered an improvement as a comfortable seat; the seats in the principal cabin may consist of cane, light wood, or lacing, as may be approved of; the fronts consisting of the best American yellow pine five-eighths boards. The seats in the steerage, eighteen inches in height, by fourteen inches in breadth, and fixed with brackets in the same manner as the principal cabin, and be seven-eighths of an inch in thickness.

The outside lining between the gunwale and top of the cabins should consist of the best yellow pine half-inch boards, well seasoned, free of knots, sound, and properly cleaned, ploughed, and feathered. The first board will extend the whole length of the cabins, eight inches in breadth, neatly joined to the covering boards, thin fitters being fitted between the standards or stancheons, and, laid in white-lead paint, so as to be water-tight, is fixed to the side standards with springs.

The space between the standards being twenty-four inches from centre to centre, it is proposed that light windows or patent gauze wire shall be placed in every alternate space, so as the passengers may have a view of the country without being under the necessity of removing to the outside. These windows and frames should be made as light as possible, and made to slide or fold, as may be considered most convenient.

The inside lining, from the seats up, and between the windows, should consist of oil-cloth, fixed and finished with beads and facings.

The top or cover of the cabins to consist of oil-cloth, which must be perfectly water-tight, and fixed to the beams, top gunwales, and ends of the cabin, with a moulding. It will be necessary to have a thin sheet of plate-iron for the funnels, so as to prevent any danger from the heat of the stoves during the winter.

The outside doors should consist of red pine plank, one inch and a quarter thick, bound and pannelled, to be hung with neat light bats and bands, have good five-inch rimmed locks, brass mounted, to open out in two halves, and to have small brass slip bolts at top and bottom. The doors in the divisions to have check locks, and hung with five-inch edge hinges.

The inside doors should consist of the best yellow pine plank, one and one-eighth inch thick, and twenty-two inches in breadth, and finished with facings.

That the whole of the inside, previous to the joiner work being commenced, should have two coats of good lead color paint, and the whole of the iron-work on the outside, as well as the wood-work in the outside and inside, should have three coats of paint of different colors, and finished in a sufficient and workmanlike manner. (*To be continued.*)

PNEUMATIC RAILWAYS.—The following is the communication from Mr. G. RALSTON, on a new, called *Pneumatic*, system of railways, referred to in our last number. It must, we think, be considered as one of the *visions* of the day; yet that is no affair of ours, as we aim to give our readers an account of whatever pertains to the subject of internal improvements, be it ever so visionary—if we imagine that any new idea may be gained from it which will or may benefit the great cause; and it is for the purpose of eliciting discussion that we lay this communication, and the opinion of Dr. Lardner and Faraday,* before our readers.

That the adoption of railroads as the means of inland transit has become a subject of deep interest to the community, and that their vast advantages are duly appreciated, is evinced not only by the ready support which is given by the public to the spirited efforts now making for their extensive application, but also by the sanction which has been accorded them by the Legislature. Indeed, at the present moment, an almost incalculable amount of capital is actually pledged to the institution of a general system of railway throughout the kingdom.

But notwithstanding the admitted advantages of railroads, as at present constructed, worked as they are by the locomotive steam engine, over the old system of transit, that splendid experiment, the Liverpool and Manchester line itself,—to the projectors and managers of which the nation is so greatly indebted for the stimulus it has given to improvements in inland transit and consequent benefit to commerce, the extent of which, indeed, are not yet fully developed,—has at the same time disclosed the inefficiency of the construction by its utter inability to withstand the violent action and tremendous concussions of the ponderous engine, which is also destroyed by its own force, and the imperfections of the locomotive system by the incompetency of the engine to work with advantage except upon a level. Hence the wear and tear of the railways in that line has amounted to not less than £500 per mile per annum, whilst the locomotive engines, of which not less than thirty* are employed upon the road, besides nearly half that number more which come upon it from branch lines, are worked and maintained at the enormous cost of more than £2,000 per annum each.

The immense expenditure of capital required in the formation and construction of the common railroad, owing in a great measure to the necessity of obtaining a nearly perfect level, and the great cost of maintaining and working the ways when they are formed, will necessarily induce the public readily to adopt any improvement which shall have the effect of increasing the *stability of the railway at a diminished cost;* and especially if it combine with it greater *security, efficiency, and economy* in the working.

The invention, which is the basis of the improvement now submitted to the public, consists in the means of applying the elastic and forcing power of the atmosphere, obtained by rarefaction, within a hollow cylinder of from thirty to forty inches in diameter, to carriages and cars *running upon rails on its outer surface;* the action being produced and transferred by means of pneumatic machinery worked by sufficiently powerful fixed or local steam engines.

Steam power, used as a first mover, admits of no application so economical as that by means of fixed engines;† and thus motive power will be obtained at one quarter the expense of that yielded by the locomotive engine. The fixed engine gives also the advantage which the locomotive does not possess, that the intensity of its force can be greatly varied to suit

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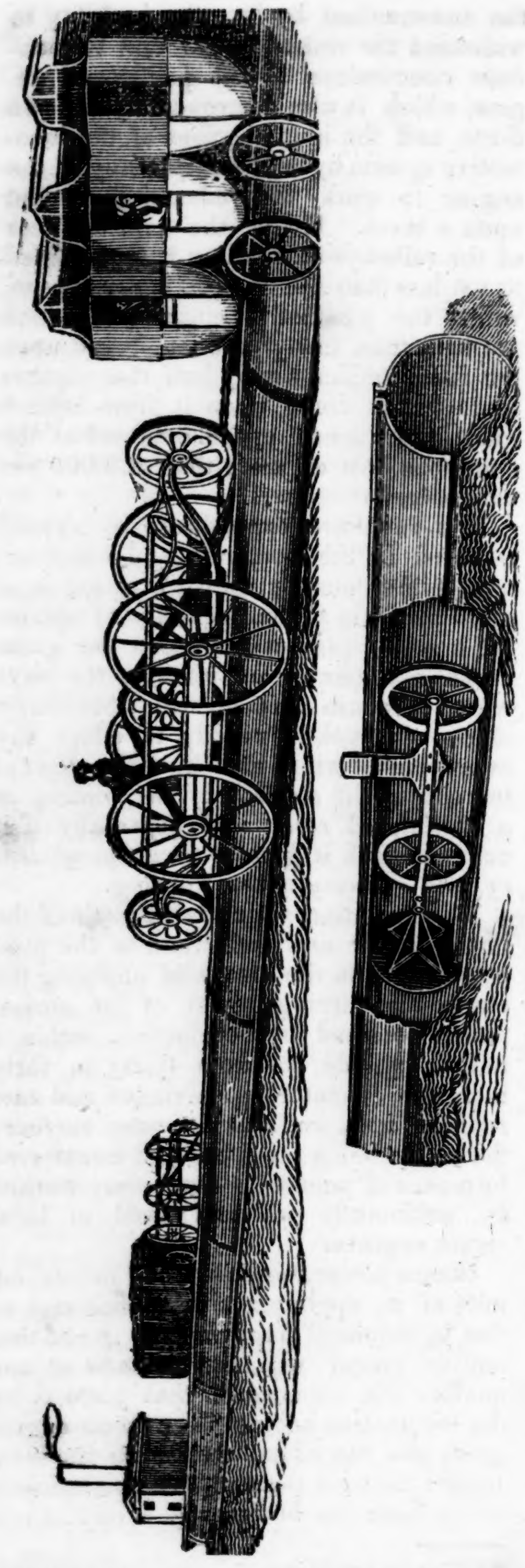
* See p. 8, current volume, of this Magazine.

* This number, at least, is possessed by the Company, though not more than half of them are at any time in working condition; the other half are always in hospital to be repaired.

† A fixed steam engine will last twenty-five years, and the deterioration will not be more than 1½ per cent. per annum.



The first figure represents a Pneumatic Railway in operation, with trains on a double track, approaching each other, one having just passed a stationary engine. ☞ This was designed to represent two trains passing a station, but by mistake the station was misplaced by the engraver.

The second figure represents a sectional view of the railway cylinder, showing the internal arrangement.

the exigencies of the road, and thus it may be rendered available according to the nature of the slope, or steepness of the acclivity to be overcome, the weight to be moved, and the degree of rapidity required. Unlike that of the locomotive engine, the power of the fixed engine is, *by the improved system*, communicated with no indirect expenditure to the load or train of carriages; whilst the power of the locomotive is first applied to bear along its own ponderous bulk, which is of about ten tons weight, or fully one fourth of its usual load, and, as before remarked, it destroys both railway and engine by its violent action and concussive force.

The power of surmounting acclivities renders the most direct lines of communication available, and thus shortens the distances between places, and avoids the necessity of circuitous routes in search of levels. Moreover, the improved system of railway permits of roads being laid through a marsh as well as over a common or down, and with no greater expense, thus affording the means, in many cases, of avoiding the annoyance, inconvenience, and expense, of running roads through parks, and over arable lands. It may be remarked, too, that the great expense involved in the formation and construction of a railroad upon the common system, is totally sunk in cutting down or in tunnelling through hills, and in building across or embanking over valleys; whereas the main expense involved in the formation of a road on the improved system, is in common iron castings, which being almost indestructible, and possessing an intrinsic value, little or no loss can accrue upon them.

Not only does the improved system present a firmer construction of the railway, and a highly economical application of power, but it affords also greater protection to life and property, in the security of the carriages and cars for the conveyance of passengers and goods, since these are so placed upon the rails, and so connected with the railway itself, that they cannot by any possibility be thrown off or overturned. In consequence of this advantage, whatever objection may exist in the public mind to travelling upon railways, because of the danger connected with the common system, will be entirely removed, and a great improvement may

be confidently calculated upon in the important item of passenger traffic.

When it is considered that, *by the improved system, a line of road may be formed and constructed for, at the most, two-thirds, and in some cases for one half, the expense involved by the common system*, and that *such a railway can be maintained and worked with far greater speed, and infinitely greater safety, for three-fourths less than the common system costs*, and that therefore *passengers and goods may be conveyed at one half the price which the common system demands, and then yield a far greater profit*, competition with the Association will be wholly out of the question.

As any degree of speed can be obtained by the improved system, with the most perfect safety, and without the disadvantage, not to say danger, arising from great velocity on the common method, a single line, on the new system, can be made, by the reciprocating plan proposed, to effect as much transit as can be effected by the use of a double line on the former, while the cost will thereby be lessened nearly one half. Hence, communications that may not warrant the expense of a double line of railway, may be advantageously occupied with a single line; numberless lines are in this manner open to the application of the new system, which the common method will not permit of being attempted.

As the invention affords the means of applying the power to the common railway, the proprietors of such must soon be found anxious to avail themselves of its advantages; and thus all the railroads in the country may soon become tributary to the Association, while the interests of the various concerns themselves will be materially improved by the adoption of the improvement.

As many millions are actually invested in this country in canals, and that species of property may be much deteriorated by the general application of railways, unless this improvement which affords them the means of increased speed is adopted by the respective canal proprietaries, the Association may fairly calculate upon rendering all these interests likewise tributary, in exchange for the advantages to be derived from the licence to apply their improved system.

In addition to affording the means of transit upon railways, whether upon the improved or with the common system, the power may in like manner be applied to *effect rapid transit, with great economy*, upon canals.

The practicability of the improvement, and the efficiency of the application, are proved by experimental operation, and confirmed by the opinion of the most eminent scientific men in the kingdom.

The following communication in relation to Pneumatic Railways has been several days in hand. The writer, who had only read the article in our last, will now have seen more in relation to it in this number.

[For the Mechanics' Magazine.]

Mr. Minor,—When will common sense be the order of the day? When shall we again be able to look upon a new scheme as one likely to prove practically useful? This is truly the age of invention and originality; but unfortunately we are still wandering in the green fields of imagination. The *Age of Reason* appears to be yet far distant. But who but a man of *original* mind could have invented either of the three plans which have been lately presented to us through the papers, as marvellously practicable, and calculated to produce a new era in the *moving power* of the world. I refer first to the invention, *by somebody*, (my bump of individuality is too small to enable me to remember all the names connected with these things,) of laying rails on the tow-path of canals, thereby incurring the expense of a road over and above the common expense of a canal, for the purpose of substituting a power upon it which can never be used.

Next comes the invention of Mr. Heron, called a "Water Power Railway:" a scheme which, besides costing at least three times as much as Mr. Heron's estimate for it, is as wanting in practical application as the former.

Lastly comes an invention from over the water, fathered also by an American, and backed by the learning of the Rev. Dion. Lardner, Mr. Faraday, &c. This is the "Pneumatic Railway," whereon we are to be impelled by the "thin air."

This is something philosophical! it is worth reasoning about! It appears that

after the railroad proper is finished, which of course must be as good, if not better, than those made at present, and consequently will cost as much, then the moving power is to be added.

According to the plan of the patentee, this is to consist of a tunnel provided with a piston, to which the cars are to be attached. The tunnel being exhausted of air by means of air pumps, worked by stationary steam engines, the piston, and consequently the cars attached to it, will be impelled by the pressure of the outward air. Suppose, with the patentee, that six stationary engines be placed between Liverpool and Manchester, they will be five miles apart. Now, when but one train of cars can be put in motion at the same time between the engines, and after a train has passed, the five miles of tunnel will have to be re-exhausted before another train can take its place, it appears to me that either more than superhuman power must be exercised in the management of the road, or that there will be very great delay in passing over it. But admitting all this to be arranged, and suppose also that there will be no insurmountable difficulty in laying down and securing the tunnel in so *exact* a manner as it must be, in order to be effective, let us look a little to the *expense* of the project.

I have no information relative to the material which the patentee intends using in the construction of his tunnel, but take it for granted that it must be of cast iron. The quantity of metal contained in a cast iron tunnel 40 inches diameter, in clear, and one inch thick, will be about 401.67 pounds for every lineal foot, or about 946.7 tons per mile.

The whole cost of the tunnel and its appendages may be estimated as follows:

Naked tunnel per mile, 946.7 tons of cast iron, at $80,	$37,868 00
Suppose the above to be cast in lengths of 5 feet; then, allowing the usual quantity of metal at the joints, this item will amount per mile to 140 tons, at $40, . .	4,160 00
Chairs, 159 tons, at $40, . .	6,360 00
Stone sleepers, ...	2,500 00
Bolts, spikes, &c., ...	500 00
Workmanship, ...	5,000 00
Total cost for a single track,	$56,388 00
Total cost for a double track,	$112,776 00

To this is to be added the cost of the railroad proper, and the stationary power to work the tunnels—say for the whole $160,000 per mile. A truly economical affair!!

Now, my dear sir, having treated the scheme of others somewhat familiarly, let me exhibit to you a plan of my own, towards which I invite the investigation of scientific men.

I propose making the whole railroad into a tunnel, either by boring the hills, or building upon the surface. Into this a piston must be fitted, to which the cars are to be attached. The *modus operandi* will of course be the same as for Mr. Perkins' tunnel. The difference between Mr. Perkins' and my own scheme is this: Mr. P. first grades his road, and then places his tunnel upon it. It is thereby insecure in the first instance, and liable to derangement ever afterwards; but by my plan, the tunnel and road are one and the same thing. In making the road, the tunnel is made also. Then, as to power, instead of a piston of 9 feet surface, we have one of 144 feet. The stationary engines I propose having outside of the tunnel over the air-shafts.

The expense of a railway of this kind will be about $175,000 per mile, or a little more than one upon Mr. Perkins' plan.

ENGINEER.

June 29, 1835.

[From the Repertory of Patent Inventions.]

Remarks on Lieutenant Rodger's Patent Anchor, with Accounts of Some Experiments, showing its Advantage over Anchors of the Old Construction.

We have, in another part of our journal, given the specification of Lieutenant Rodger's patent for anchors. We have been favored with accounts of a great variety of experiments, together with numerous testimonials, on the result of the practical application of these anchors, which have now made very considerable progress towards coming into general use. On first reading the specification, we were struck with the proposition, that an anchor to be most effective must have the smallest possible flukes, a proposition the very reverse of the theory on which anchors have been constructed for ages.

When we consider the number of lives, and the extent of property which are hourly at stake in various quarters of the globe, and often wholly dependent on the well or ill holding of anchors, we shall be pardoned in taking up some of the pages of our present number with a view to call attention to the present invention, and we cannot perform this important task better than by laying before our readers a few of the experiments. Before we proceed, we are desirous of making some observations on the principles on which the present anchor rests its claims of superiority.

Heretofore it has been universally believed that the holding power of an anchor was in proportion to the size of the palms, than which nothing could be more erroneous; for the fact is, to a certain limit, it is inversely as the size of the palms; and the patentee has availed himself of that size (relative to the length of the arms) which produces the maximum effect, with an anchor of a given weight and length; and which palm is extremely small in comparison with that in general use, (as may be seen on examining the specification.) This reduction of size places at disposal more than one ninth of the whole weight of the anchor, which enables the maker not only to lengthen the shank, which is considered a great desideratum, but at the same time to add to its strength by increasing its dimensions transversely. Were it not for the convenience of fishing the anchor with a hook, in the usual way, the palms might be still further reduced, without materially lessening their power of holding, for even the bare arm, without any palm, is much more effective than the large palm in common use, both as regards taking hold, and retaining it, and that too in soft ground. This may, probably, be considered a bold assertion; but the patentee is fully borne out by the result of more than 250 experiments, which he has made with palms of eighteen different sizes, for an anchor of the same weight; commencing with one half the usual size; and after comparing its power of holding with that of the large palm in common use, by an average of several experiments, made with each alternately, he reduced his improved palm by eighteen gradations, and compared the holding power of each with that of the large palm in the same manner as the first, until at last no palm was left; and strange as it may appear at first, he actually found, that although the arm with the large palm was buried up to the shank in a vessel nearly filled with sand, and covered with water, much less power, applied horizontally, overcame its resistance, and actually pulled it out of the ground, than was required to drag the *bare arm without any palm*. He also found that by increasing the size of the common palm, with the same length of arm, the anchor became less effective than in its present state. The limits of this paper will not admit of a full explanation of these paradoxes; but nevertheless, the above statement, corroborated by the annexed experiments, will receive due credit from every person concerned in nautical improvements. We may briefly state, however, that the inefficiency of the large palm is owing to its loosening the ground, and to its liability to get shod, and its consequent tendency to rise out of the ground; and when this takes place, no dependence can be had on its again taking hold; therefore, another anchor must be let go, when it would otherwise have been desirable to ride by one.

The small palm, on the contrary, does not disturb the ground at the surface; this is to be attributed to its making a more favorable angle with the ground, which gives it a natural tendency to penetrate deeper, until obstructed by the shank, and without the least liability to get shod. This being the case, a ship will seldom, if ever, run away with an anchor with small palms; which, if dragged, will again take hold, with a sufficient scope of cable; for it has no tendency whatever to rise out of the ground. Anchors with small palms are likewise much stronger than those in common use of the same weight, in consequence of the iron heretofore put in the palms, amounting to more than one ninth of the whole, being diffused over the shank and arms; the sectional form of which is also worthy of notice, as uniting a greater amount of strength and flexibility, with a given quantity of material, than is to be obtained by any sectional form in common use; together with the certainty of making the iron of a better quality. It

will likewise be observed, that the shank of the patent small-palmed anchor is longer than usual in proportion to the arms; and from this it derives a double advantage, for it not only makes it easier weighed, but causes it to take immediate hold, and to retain its hold better than an anchor of equal weight, with the same length of arms, and a shorter shank. The small palms likewise greatly facilitate canting the anchor, as they do not touch the ground when the anchor is resting on the crown, and one end of the stock; which, it will be perceived, may be made of one or two pieces of timber; and the anchor may be stocked or unstocked in a few minutes without the assistance of a carpenter, and is, besides, much more secure than on the old plan.

Trials of the Comparative Power of Holding of Lieut. Rodger's Patent Small-Palmed Anchor and an Anchor on the Old Construction, showing the weight of each, and the distances dragged in the different Experiments.

No. of Trials.	Patent Anchor.			Common Anchor.		
	cwt.	qr.	lb.	cwt.	qr.	lb.
	4	0	6	4	0	9
	Distance dragged.			Distance dragged.		
	ft.	in.		ft.	in.	
1st trial, . . .	12	8		32	6	
2d do. . . .	21	4		30	0	
Sum,	34	0		62	6	

Place of Trial, and Remarks.—On the sand on the south shore, a little below Messrs. Hawks & Co.'s Manufactory, at Gateshead. The power consisted of two treble blocks and rope fall, with 16 men on each end of the fall. During part of the 2d trial, a weight equal to 1 cwt. 2 qrs. 11 lbs. was placed on the shank (in a line with the points) of the common anchor. The ground consisted of clean sand.

Gateshead, Nov. 28, 1833.

No. of Trials.	ft.	in.	ft.	in.
1st trial, . . .	9	0	39	0
2d do. . . .	8	0	47	0
Sum,	17	0	86	0

Place of Trial, and Remarks.—On the Coble Landing, South Shields. The purchase as above, with 20 men on each end of the fall. The ground consisted of a mixture of sand and clay.

South Shields, Dec. 3, 1833.

No. of Trials.	ft.	in.	ft.	in.
1st trial, . . .	5	3	59	0
2d do. . . .	7	0	45	0
Sum,	12	3	104	0

Place of Trial, and Remarks.—On the Coble Landing, South Shields. The purchase, &c., as above.

South Shields, Dec. 5, 1833.

No. of Trials.	ft.	in.	ft.	in.
1st trial, . . .	12	0	51	0
2d do. . . .	7	6	54	0
3d do. . . .	5	0	51	0
Sum,	24	6	156	0

Place of Trial, and Remarks.—At the back of Sunderland South Pier. The purchase as at South Shields. The ground consisted of a mixture of sand and gravel.

Sunderland, Dec. 12, 1833.

In all the above experiments the anchors were placed on a level, (between the high and low water marks,) about 60 feet apart, and drawn together by means of a tackle. After the first trial the anchors were reversed and tried again; and it was observed that the difference was greatest when the patent anchor was in firm ground.

Trials of the Comparative Power of Holding of Lieut. Rodger's Patent Kedge Anchor without Palms, and Kedges on the Old Construction; showing the weight of each, and the distances dragged in two Series of Experiments. The first upon the sand on the south shore, Gateshead; and the second upon the Coble Landing, South Shields.

First Series.	Patent Kedge.			Dist. drag'd.		Common Kedge.			Dist. drag'd.	
	c.	q.	lb.	ft.	in.	c.	q.	lb.	ft.	in.
1st and 2d trials,	1	0	0	43	0	1	0	5	105	0
3d and 4th do.	1	0	0	48	0	1	2	1	89	0
5th and 6th do.	1	0	0	72	0	1	3	24	56	6
Sums,	3	0	0	163	0	4	2	2	250	6
Means,	1	0	0	54	4	1	2	0½	83	6

July 8, 1834.

Second Series.	Patent Kedge.			Dist. drag'd.		Common Kedge.			Dist. drag'd.	
	c.	q.	lb.	ft.	in.	c.	q.	lb.	ft.	in.
1st and 2d trials,	1	0	0	38	6	1	0	5	93	6
3d and 4th do.	1	0	0	36	0	1	2	1	100	6
5th and 6th do.	1	0	0	77	0	1	3	24	59	9
Sums,	3	0	0	151	6	4	2	2	253	9
Means,	1	0	0	50	6	1	2	0½	84	7

July 9, 1834.

The ground consisted of clean sand, on which the kedges were placed on a level, (between the high and low water marks,) about 80 feet apart, and drawn together by means of a tackle composed of two double blocks and a chain fall, with 26 men on each end of the fall. And each kedge, after its first trial, was reversed and tried again.

The ground consisted of sand and clay, on which the kedges were placed as above, and drawn together by means of 20 men on each end of the fall.

By the above statements it will be seen, that in the 1st series of experiments the patent kedge of 1 cwt. was dragged 163 feet, and the common kedges of 1 cwt. 0 qrs. 5 lbs., 1 cwt. 2 qrs. 1 lb., and 1 cwt. 3 qrs. 24 lbs., were dragged 250 feet 6 inches; and if the means of the weights and distance be taken, we shall have—Patent kedge, of 1 cwt., dragged 54 feet 4 inches; common kedge, of 1 cwt. 2 qrs. $0\frac{2}{3}$ lb., dragged 83 feet 6 inches; which is in the ratio of rather more than 3 to 2.

In the 2d series the mean is: Patent kedge, of 1 cwt., dragged 50 feet 6 inches; common kedge, of 1 cwt. 2 qrs. $0\frac{2}{3}$ lb., dragged 84 feet 7 inches; which is in a still higher ratio than the former, although the weight of the common kedge was one half greater than that of the patent.

And there can be no doubt, that had the ground been harder, or of a more adhesive quality, the result of the experiments would have been still more favorable to the new plan. In addition to the few observations with which we have thought it desirable to preface this subject, in thus laying before our readers the various results of the experiments above given, we should not be doing full justice to the patentee if we were to close our notice without stating that we have a very large packet of communications from captains and pilots of vessels, who have tried the patent anchors under every circumstance of weather and anchorage. We have also copies of votes come to, in favor of the new anchors, by general meetings of the Nautical Assurance and other companies of South Shields, strongly recommending the patent anchors.

The Book of Science, adapted to the comprehension of Young People.

MECHANICS.

There is perhaps no department of Natural Philosophy of such extensive importance as Mechanics, since its principles are founded on those properties of matter which are among the most obvious and essential,—namely, Mobility and Weight; and the effects produced by the operation of these properties are so distinct and certain, that they can be subjected to mathematical calculation. Hence Dr. Wallis has described Mechanics, with some degree of propriety, as the "Geometry of Motion."—The designation of this branch of knowledge, like most other scientific terms, is derived from the Greek: the word *Mechane*, signifying a *Machine;* and Mechanics may be considered as the Philosophy of Machinery, or the Theory of Moving Powers. Many writers have treated of this science under two heads, regarding those principles which relate to the gravity or weight and to the equilibrium of bodies, or the powers which preserve bodies in the state of rest, as the subject of the doctrine of Statics;* and the principles relating to the causes of movement, or the forces producing motion, acting by means of solids, as forming the subject of the doctrine of Dynamics.† But, as the respective states of bodies at rest and bodies in motion may be most correctly considered as the consequences of different modes of action of the same causes, they may be instructively illustrated by showing their relations to each other, for which reason it will be proper to treat of them in conjunction, rather than separately.

From this statement of the nature and objects of Mechanics, it will at once appear that we have by no means overrated the importance of an acquaintance with this science to the Student of Natural Philosophy. For all motions are more or less subjects to the laws of Mechanics, and without a knowledge of those laws, it is impossible to appreciate the effects or calculate the consequences of those motions of the celestial bodies which occasion the phenomena of Astronomy; or of those properties of fluids, whether liquid or gaseous, on which depend the principles of Pneumatics, Hydrostatics, and Hydraulics; or indeed of any circumstances affecting the ponderable forms of matter. And those sciences which relate to heat, light, electro-magnetism, vital power, either in animals or vegetables, or any other phenomena which appear to be independent of the force of gravitation, yet derive most important aid from Mechanics; for it is chiefly by means of mechanical instruments that the influence of heat, light, electricity, magnetism, or the effects of vitality, as in the motion of the blood in animals, or of the sap or other fluids in vegetables, can be estimated. Mechanics may therefore be considered as the basis or groundwork of the other Physical Sciences, or branches of Natural Philosophy.

Previously to entering on the consideration of the Theory of Mechanical Powers,

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* From the Greek verb *Stao*, to stand, or be fixed; or from *Stasis*, the act of standing.

† From the Greek word *Dunamis*, power, or force.

it will be necessary to show the nature and effects of mobility, or the capacity for motion, and of weight, or the gravitation of bodies,—as these are the general properties of matter on which, as already stated, the phenomena of Mechanics depend.

Mobility.

Every individual body, or portion of matter, must take up a certain space. This may be considered as the absolute place of the body, in reference to its situation simply and singly; or as its relative place, or situation with respect to other bodies. The relative situation of a body may be changed either by its own motion, or by the motion of the bodies around it. A body may exhibit the appearance of actual motion, or absolute change of place, while it remains at rest, its change of place being only relative. Thus, the moon, when a train of thin fleecy clouds is passing over its face, if we attentively fix our eyes on it, seems to move, and the clouds to stand still, though this is only an apparent motion of the moon, in a direction contrary to that in which the clouds are really moving. And if we hold a common eye-glass, or any transparent substance, a few inches before the eyes, and move it backwards and forwards, looking through it at any object, as an ink-stand or knife, which remains unmoved, it will, as in the former case, exhibit an apparent motion, arising from the actual movement of the glass.

Mobility is the capacity of a body for change of place by its own motion; it therefore infers the capability of real or actual motion, and not of relative motion only. Yet this change of place may sometimes be most readily estimated by the consequent relative motion which accompanies it. Thus, a person sailing in a boat on a smooth stream, or going swiftly in a coach along an even road, would hardly perceive the motion of the vehicle except by the change of scene, and trees or buildings on the banks of the stream, or by the road-side, would seem to move in an opposite direction from that of the real motion of the boat or carriage. Every tolerably well informed person now admits that the earth moves, and the sun stands still; but the motion of the former is not perceptible, and the apparent daily motion of the latter, being so obvious to our senses, was, till within the last three centuries, considered as a real motion, the existence of which could not even be questioned with impunity.

Without some active cause motion can neither commence nor cease; since a body in the state of rest would always remain unmoved, if never subjected to the influence of a moving force, and, on the contrary, a body when set in motion would go on to move for ever, if it met with no opposition to its progress. It may seem inconsistent with this doctrine that any body set in motion, within the range of our observation, will continue to move without a fresh impulse for a time, but at length will slacken its speed, and finally resume the state of rest. Thus, a cannon-ball will pass a certain distance when discharged from the mouth of a cannon, but if it does not strike a solid body, still it will ultimately fall to the ground; and a marble or a cricket-ball thrown forwards with the hand, if it meet no obstacle, will reach only a certain distance, proportioned to the force used in throwing it. In both these and all similar cases, the termination of the motion of the moving body is owing chiefly to two causes. The first of these is gravitation towards the earth's centre, common to all bodies, and which constantly tends to keep them at rest, pressing on the surface of the earth with a degree of force proportioned to their weight and bulk; or, if, as in the case of the cannon-ball, they pass through the air, the force of gravitation then tends to draw them continually nearer to the earth, till at length they fall and rest upon it. But the second and more obvious cause of the decay of motion is the resistance of the medium through which the moving body takes its course; and thus, a body moving through the air, like the cannon-ball, gradually becomes less and less able to pass forward till its moving force is destroyed. It will be readily perceived that the resistance of the medium to the body which passes through it must depend much on its density or consistence; thus, a ball driven by a certain force would pass farther through the air than through water, and farther through the latter than through a denser fluid, as brine or syrup, or through solids, as sand or clay. Another circumstance which will affect the motion of a body, with relation to the medium through which it travels, must be taken into the account, and this is the form of the moving body. A small body will meet with less resistance than a large one of the same weight; and a body which presents an extensive surface to the medium through which it moves, will be retarded in its passage much more than one with a small surface. A sheet of paper stretched out to its full extent, and suffered to fall a few feet, and then folded up into a small compass, and again suffered to fall from the same height, will afford an exemplification of the resistance of the atmosphere to falling bodies; and an illustration of a different kind, but to the same purpose, may be drawn from the advantage which sharp-edged and pointed instru-

ments have over blunt ones in penetrating hard or tough substances. A body moving in contact with a solid substance, as when it is rolled or dragged along the ground, is also affected by friction. This obstacle to motion is proportioned to the roughness or smoothness of the surface over which the body passes: thus, a marble thrown with any given force will run much farther along an even pavement, than along an equally level gravel walk; and still farther along smooth ice. Here again the form of the moving body has much influence on the velocity and extent of motion; for the fewer the points of contact between the surface and that which passes over it, the more freely will motion take place.

All bodies subject to our control are exposed to the operation of gravity, in various degrees, and from this cause, independent of the resistance of the medium which they traverse, or of the effect of friction, their motions cannot be indefinitely continued, but must decline and terminate in a given time, according to the circumstances in which they are placed. But though perpetual motion cannot be exhibited by any methods which human skill or industry can contrive, yet we have continually before us the display of bodies which have been moving with undiminished velocity for ages past, and which no power but that which governs all nature can prevent from moving in the same manner for innumerable ages to come. The bodies to which we refer, as will probably be anticipated, are those whose motions are the objects of the science of Astronomy; and though that subject will not come under our immediate discussion, yet the general nature of the forces which occasion the revolution of the celestial bodies will be explained, and the causes of their uniform and uninterrupted motion will be illustrated.

That state of bodies just described, in which motion or the cessation of motion can take place only in consequence of an extraneous cause, has been termed Inertia, which signifies inactivity, equally opposed to motion when at rest, and to rest when in motion; so that, if a given force is required to make a body move with a certain velocity, the same force will be required to destroy its motion. When a garden roller is being drawn along a level grass-plot, the exertion necessary to stop it suddenly, at any given point, would be precisely the same as would be required to move it backward, if it were at rest, and of course the same that was applied to set it in motion at first.

Any force applied to produce motion may be called Power, or impulse, which may be either continued, as in the case of pressure, or intermitting, as in the case of impact or percussion. Whatever opposes motion so as to retard the moving body, destroy its motion, or drive it in a contrary direction, may be termed Resistance, and its effect, re-action or counteraction. It is one of the laws of motion that action and re-action are always equal and contrary. Thus, in pressing down the empty scale of a balance, while the other scale held a five-pound weight, it is obvious that the force exerted must be equal to five pounds; but if one scale had been loaded with fifteen pounds, and the other with only ten, the equilibrium might still be preserved by pressing on the latter with a force equal to five pounds only. And if a man, sitting in a boat on a canal, draws towards him, by means of a rope, another boat of equal weight, they will meet at a point half-way from the places whence they began to move. Suppose, however, the second boat to be so laden as to be twice the weight of the first, it must move the slower of the two, and consequently the point of meeting would be nearer the second boat than the first. If a body in motion strikes another body of equal mass at rest, the two bodies will move together, but with only one half the original velocity of the first, the other half having been expended in overcoming the inertia of the second body. Corresponding effects will take place, whatever difference there may be between the masses of the two bodies; for if the second body should be double the mass of the first body, the common velocity after the impact of the two bodies would be one-third that of the first; and if the mass of the first body be to that of the second as 5 to 7, the common mass after impact will be 12, and as the second will deduct from the motion of the first in proportion to its mass, the motion lost by the first body will be seven-twelfths, and the motion retained would be five-twelfths. If two bodies are both in motion in the same direction, and one overtake and impinge on the other, suppose the masses of the two bodies to be the same, and the velocity of the first to be 7, and that of the second to be 5, their common velocity after impact will be 6, or half the sum of the two velocities. But if the masses are unequal, the mass of each must be multiplied separately by its velocity, and the products added together, and their sum divided by the sum of the two masses will give the common velocity. When two bodies are moving in opposite directions, with the same velocity, and having equal masses, action and re-action being equal, both motions will be destroyed. Suppose, however, the masses to be alike, and the velocity of the first body to be 10, and that of the other to be 6, the first body will lose 6 parts of its ve-

locity, which will be requisite to neutralize or destroy the opposite velocity of the second body, and the remaining 4 parts of the velocity of the first body being divided between the two, they will move together in the direction taken by the first body with a common velocity equal to 2. When the masses, as well as the velocities, are unequal, the common velocity of two bodies after impact may be found by multiplying the numbers denoting the masses by those expressing the velocities respectively, subtracting the lesser product from the greater, and dividing the remainder by the sum of the numbers denoting the masses: the quotient will then show the velocity with which the bodies will move together, in the direction of the body having the greatest quantity of motion.

[For what follows see page 35, of the Apprentice's Companion, "Equality of Action and Re-action in the Collision of Bodies."]

[From the Springfield, Mass. Gazette.]

Temperance Anecdote, *illustrating the happy influence of a single Tract or Tale upon a whole village.*—A gentleman, not a great while since, in passing through a small village, when on a journey, met with a slight accident to his carriage, which detained him there some time in getting it repaired. While there, he entered the lowly habitation of one of the villagers, the occupant of which was an intelligent woman, who was a widow. After conversing some time on various subjects, her own domestic circumstances being alluded to, she said that her family had once been wretched in the extreme; and intimated to the stranger, in a feeling and delicate manner, that her husband contracted in early life habits of intemperance, and died under their influence—that her son, her *only* son, followed in the footsteps of his father, and became a sot.

After the death of her husband, a friend at a distance had sent her a little book; after reading it herself with intense interest, she induced her son and several other individuals in the village to read it also. Her son soon after became a reformed man, and has continued so ever since. Such was the case also with others who read it. A temperance society was soon formed, to which a multitude of all classes promptly joined themselves, and this little village experienced an entire moral renovation, through the influence of this single book.

On being inquired of by the stranger, what the little book was that produced such happy effects, she said she had kept it very choice in her desk—"for," said she, "next to my Bible, I prize it above all other books." She soon produced it, and taking off the paper in which it was enveloped, presented it to the stranger, who immediately recognized it as a familiar friend. It was "My Mother's Gold Ring," and the stranger who then held it was Lucius M. Sargent, *the author*. What emotions of delight must have filled the bosom of Mr. S. on this occasion! Who would not value such feelings infinitely more than all the unhallowed gains that were ever realized from the traffic in ardent spirit?

Before leaving the cottage of the widow, Mr. Sargent presented her with the entire series of his Temperance Tales.

The above anecdote we received from such a source, that it may be relied upon as substantially correct.

Could we imagine that such important results would attend the reading of a whole volume of *this* work, *we* should feel amply compensated for all our exertions to give it an extensive circulation.—[Ed. A. C.]

India Rubber.—Although so many establishments are in active operation for the manufacture of India rubber, such is the manifest utility of the articles made of it, and such the demand for them by the most intelligent people, that it may be safely said that the whole business is still in its infancy. It is a curious circumstance in the recent history of this novel fabric, that those countries from whence the raw material is drawn, without the least question, must ultimately become the greatest market for India rubber goods in the world. Indeed, tropical climates, of all others, require the clothes and casings which none but New-Englanders seem to understand how to make. The rainy seasons of equatorial regions have been regarded with perfect dread, on account of the utter impossibility of venturing beyond the threshold, without being instantly drenched under those torrents of rain which appear to fall directly from the windows of heaven, and from which no other kind of covering could shield the body. Since the discovery of India rubber cloth, the entire aspect of those deluged countries will be changed. Men may now go abroad for the transaction of business, fearless, though the rains descend in torrents, perfectly comfortable, under the protection of garments so light that the freedom of the body suffers no restraint. One great obstacle to the active operation of armies in the tropical countries has been the periodical rains, destructive alike to soldiers and military armaments. A simple India rubber watch coat and cap completely shuts out the storm, so

that nothing short of a flooding of the land could impede the march of soldiery, dressed in these beautifully devised habiliments.

But without all these boundless avenues for the consumption of manufactured India rubber, our own country alone, before the completion of two years more, cannot be supplied by the united labors of all the manufactories of Boston and its vicinity; hence the value of the corporate property must be constantly increasing; for new conveniences, and unlooked-for contrivances, indispensable even in domestic life, as well as in the useful arts and sciences, are daily being discovered, and which can only be constructed economically from this singular elastic gum. Viewing the progress of discovery, as it especially regards this one article, our admiration is raised, and our wonder excited, by the ingenuity and skill displayed in the various adaptations of India rubber to the daily, and even hourly wants of mankind.—[Scientific Tracts.]

Salt of Caubul.—Mr. Elphinstone, an observing traveller in the kingdom of Caubul, in Persia, says, at Callabaugh, the river Indus is so compressed between mountains, that at that particular place it it is only three hundred and fifty yards wide. On each side, the mountains are so abrupt in their descent towards the water, that a road has been cut along the base on one side, upwards of two miles. A little beyond this terrifying pass, the road is excavated out of solid mineral salt. Cliffs of salt, hard and clear like crystal, occasionally tinged with streaks of red, overhang this astonishing highway, more than a hundred feet high. Salt springs are frequently seen, bubbling up salt water, which, crystallizing in the sun, leaves the surface, in the neighborhood of the springs, frosted with crystals of the most dazzling brilliancy. Near the town the soil is almost of a blood red color, which, together with the strange yet beautiful spectacle of the salt rock, and the majestic Indus flowing through the serpentine channel of the mountains, constitutes a scene of indescribable wonder and thrilling astonishment.—[Ib.]

[From the London Penny Magazine.]

As an antidote against *all* intemperance, whether of the rich or the poor, we print an impressive paper, descriptive indeed of an imaginary case, but possessing all the force of truth. It is understood to be from the pen of the late Mr. Lamb.

CONFESSIONS OF A DRUNKARD.

"Could the youth to whom the flavor of his first wine is delicious as the opening scenes of life, or the entering upon some newly-discovered paradise, look into my desolation, and be made to understand what a dreary thing it is when a man shall feel himself going down a precipice with open eyes and a passive will—to see his destruction, and have no power to stop it, and yet to feel it all the way emanating from himself; to perceive all goodness emptied out of him, and yet not to be able to forget a time when it was otherwise; to bear about the piteous spectacle of his own self-ruins: could he see my fevered eye,—feverish with last night's drinking, and feverishly looking for this night's repetition of the folly; could he feel the body of the death out of which I cry hourly with feebler and feebler outcry to be delivered,—it were enough to make him dash the sparkling beverage to the earth in all the pride of its mantling temptation.

O! if a wish could transport me back to those days of youth when a draught from the next clear spring could slake any heats which summer suns and youthful exercise had power to stir up in the blood, how gladly would I return to thee, pure element, the drink of children, and of child-like holy hermits! In my dreams, I can sometimes fancy thy cool refreshment purling over my burning tongue. But my waking stomach rejects it. That which refreshes innocence only makes me sick and faint.

But is there no middle way betwixt total abstinence and the excess which kills you? For your sake, reader, and that you may never attain to my experience, with pain I must utter the dreadful truth, that there is none, none that I can find. In my stage of habit, (I speak not of habits less confirmed, for some of them I believe the advice to be most prudential,) in the stage to which I have reached, to stop short of that measure which is sufficient to draw on torpor and sleep,—the benumbing apoplectic sleep of the drunkard,—is to have taken none at all. The pain of the self-denial is all one. And what that is I had rather the reader should believe on my credit than know from his own trial. He will come to know it whenever he shall arrive at that state in which, paradoxical as it may appear, *reason shall only visit him through intoxication:* for it is a fearful truth, that the intellectual faculties, by repeated acts of intemperance, may be driven from their orderly sphere of action, their clear day-light ministeries, until they shall be brought at last to depend for the faint manifestation of their departing energies upon the returning periods of the fatal madness to which they owe their devastation. The drinking man is never less himself than

during his sober intervals. Evil is so far his good.

Behold me, then, in the robust period of life, reduced to imbecility and decay. Hear me count my gains, and the profits which I have derived from the midnight cup.

Twelve years ago I was possessed of a healthy frame of mind and body. I was never strong, but I think my constitution, for a weak one, was as happily exempt from the tendency to any malady as it was possible to be. I scarcely knew what it was to ail any thing. Now, except when I am loosing myself in a sea of drink, I am never free from those uneasy sensations in head and stomach which are so much worse to bear than any definite pains and aches.

At that time I was seldom in bed after six in the morning, summer and winter. I awoke refreshed, and seldom without some merry thoughts in my head, or some piece of a song to welcome the new-born day. Now, the first feeling which besets me, after stretching out the hours of recumbence to their last possible extent, is a forecast of the wearisome day that lies before me, with a secret wish that I could have lain on still or never awaked.

Life itself, my waking life, has much of the confusion, the trouble, and obscure perplexity of an ill dream. In the day-time I stumble upon dark mountains.

Business, which, though never particularly adapted to my nature, yet as something of necessity to be gone through, and therefore best undertaken with cheerfulness, I used to enter upon with some degree of alacrity, now wearies, affrights, perplexes me. I fancy all sorts of discouragements, and am ready to give up an occupation which gives me bread from a harassing conceit of incapacity. The slightest commission given me by a friend, or any small duty which I have to perform for myself, as giving orders to a tradesman, &c., haunts me as a labor impossible to be got through. So much the springs of action are broken.

The same cowardice attends me in all my intercourse with mankind. I dare not promise that a friend's honor, or his cause, would be safe in my keeping if I were put to the expense of any manly resolution in defending it. So much the springs of moral action are deadened within me.

My favorite occupations in times past now cease to entertain. I can do nothing readily. Application, for ever so short a time, kills me. This poor abstract of my condition was penned at long intervals, with scarcely any attempt at connexion of thought, which is now difficult to me.

The noble passages which formerly delighted me in history, or poetic fiction, now only draw a few weak tears allied to dotage. My broken and dispirited nature seems to sink before any thing great and admirable.

I perpetually catch myself in tears, for any cause or none. It is inexpressible how much this infirmity adds to sense of shame, and a general feeling of deterioration.

These are some of the instances concerning which I may say with truth that it was not always so with me.

Shall I lift up the veil of my weakness any further, or is this disclosure sufficient?"

[From the same.]

Mineral Kingdom. *Gold.*—This metal possesses above all others the qualities of utility and beauty, without any deleterious property. It has been in all times regarded as the most perfect and most precious of the metals, and among the more civilized nations has been the standard of value for other commodities. Its peculiar rich hue is well known; and it is the only metal of a yellow color. In its pure state it is as soft as tin, and is very flexible, but it is capable of receiving a high lustre by polishing with a burnisher, although inferior in brilliancy to steel, silver, and mercury. It possesses little elasticity or sonorousness. Its specific gravity is 19·30—that is, it is more than nineteen times heavier than water, bulk for bulk. In *malleability* it exceeds all other metals; for one grain of it can be beat out into a leaf so thin as not to exceed $\frac{1}{280000}$th part of an inch in thickness, and which will cover fifty-six square inches; in this state, notwithstanding the high specific gravity, it will float in the air like a feather. But even that is not the extreme limit to which it is capable of being extended; for a coating of gold, which is calculated to be only one-twelfth part of the above thickness, is produced by another process: if a silver wire be covered with gold, it may be drawn out into wire of still greater fineness, and retain a coating of gold; and one grain of gold will in this way coat a surface of wire about two miles and three-quarters in length. In *ductility* it also exceeds all other metals; that is, it can be drawn into finer wire than any other. In *tenacity*, however, it is greatly inferior, standing only fifth in order, in respect of that property when compared with other metals: a wire $\frac{1}{13}$th of an inch in thickness will not support a greater weight than 150 lbs., whereas iron wire of the same diameter will sustain a weight of 550 lbs. without breaking. It is not a perfectly opake body like all the other metals, for gold leaf transmits a green light; as may be conveniently

observed by laying a leaf between two thin plates of colorless glass, and holding it between the eye and a strong light. It is less fusible than silver, and more so than copper: Mr. Daniel estimates its melting point to be at a heat equal to 2016° of Fahrenheit's scale. It is the most perfect of all conductors of heat; that is to say, if heat be applied to one end of a rod of gold, it will be transmitted from particle to particle, and become sensible at the other extremity of the rod more quickly than through any other substance in nature. Thus while the conducting power of a rod of porcelain is represented by a velocity of 12, of lead by 179, of iron by 374, the velocity of gold is 1000. Gold may be exposed for ages to air and moisture without undergoing any alteration; and a quantity of it has been kept for thirty weeks in a melted state in a glass-house furnace without the loss of a single grain, and without any change in its nature. But if a small portion of it be intensely heated by electricity, or by the oxy-hydrogen blow-pipe, it burns with a greenish blue flame, and is dissipated in the form of a purple powder.

Gold is found, almost universally, in the native or metallic state; but it is seldom quite pure, being generally alloyed, in greater or less degree, with other metals, and usually with silver, copper, or iron. The Prussian chemist, Klaproth, found a native gold from the Altai Mountains to contain as much as 36 per cent. of silver; and Professor G. Rose, of Berlin, by more recent analysis, has found a specimen from the same district to contain 38 per cent., and another from Hungary nearly 39 per cent. He found the gold of the Ural Mountains to contain from 2 to 15 per cent. in general; but one variety so free from foreign admixture as to contain nearly 99 per cent. of pure gold. Boussaingault has found the native gold of Colombia to contain from 2 to 36 per cent. of silver. It is found in veins in the primary and older sedimentary rocks, and also in the unstratified rocks that are associated with these, such as granite, porphyry, and hornblende rock; and sometimes, also, in the more ancient of the secondary strata. The veinstone in which the gold occurs is most generally quartz. In Transylvania small quantities of an ore have been found, in which gold is in combination with a considerable proportion of the rare metal *Tellurium;* and there is a kind of iron pyrites—that is, a sulphuret of iron,—not of very unfrequent occurrence, which contains minute scales of pure gold interposed between the laminæ of the pyrites. When gold occurs in veins in solid rocks, it is sometimes regularly crystallized. In the splendid collection of minerals belonging to the Russian noble, Prince Demidoff, there are many beautiful crystals of gold from the Ural Mountains. By far the greatest proportion of this metal, in all countries which produce it, is obtained from alluvial soils, or deposites, where the gold is found in scales, grains, and lumps, rounded by attrition: so that the metal has evidently been derived from pre-existing rocks, in which it was disseminated either in minute scales or veins, and which have been broken up; the fragments having been abraded by the action of water in the same manner as the pebbles of tin-stone in the stream-works of Cornwall, and other places. For the sake of convenience, we shall call this "*stream-gold.*" It is found in the sand and gravel of the beds of many rivers and smaller streams in most countries of the world; but the chief quantity is met with in extensive alluvial deposites, formed by other aqueous causes than the water of existing rivers. The lumps of gold, in such situations, are of very various sizes; and masses have been found in the Ural Mountains of eighteen and twenty pounds weight,—in Colombia, of twenty-five pounds; and one is said to have been found near La Paz, in Peru, of nearly forty-five pounds weight, the value of which, if estimated at 3*l*. 10*s*. per ounce, would be 1890*l*. A considerable portion of stream-gold appears to have been derived from auriferous pyrites; for almost all the sands from which this metal is gathered are of a deep blackish-brown color, and are highly ferruginous. It is a remarkable and not a very explicable circumstance that, in countries which contain deposites of alluvium rich in gold, and the materials of which must have been derived from rocks at no very great distance, it has rarely happened that the attempts to find the metal in the neighboring rocks have been successful. It may be asked, how gold comes to be so often found in alluvial soils, and that other metals should not be met with in the same way? Platinum is so found, and so is silver, but only very rarely. The reason is, that the ores of other metals are liable to decomposition by exposure to air and moisture; and, therefore, although they might have been originally in fragments, like the other materials of the rocks that were broken up, they would gradually disappear by decomposition; whereas the gold, from its indestructible nature, remains unchanged, except in form. In the same way stream-tin has been preserved, because the oxide of tin is not affected by air and moisture.

To describe the methods employed to separate gold from the other minerals with which it is combined would lead us into

somewhat tedious details. The great value of gold makes searching after minute quantities profitable, which would never be practised with other metals. The usual mode of separation is by a process called *amalgamation*, which is founded on the property which mercury (or quicksilver) has of combining very readily with gold, and of being easily separated from it again by the application of heat. The etymology of the word is Greek, viz., *ama, together*, and *gameo, to marry;* expressive in this way of the union of the gold with the quicksilver. Amalgamation is effected in this manner: the ore, broken to pieces and freed as much as possible from stony impurities, is reduced to powder, and made up into a paste with salt and water. Quicksilver in proper proportion is added, and the whole is well beaten and shaken together, and kept at the temperature of boiling water for some days, till the union is effected; after which the earthy matter is washed away, and the residue is subjected to distillation, by which the quicksilver is separated, and at the same time recovered in great part, and the gold, usually containing a little silver, is left behind. This is the usual process followed in Mexico and South America. In Hungary the gold is generally purified by another process, called *cupellation.* This depends on the property which lead and copper, the metals with which the gold is there mixed in the ores, have of attracting oxygen from the air when exposed to a strong heat, and which the gold does not. The ores are well roasted, to drive off the sulphur they usually contain, and are fused in several successive operations. The metallic mixture, freed from stony matter thus obtained, is put into a vessel made of bone-ashes, called a *cupel;* it is made of that material because it forms a porous texture, and is, at the same time, very refractory in the fire. A strong blast of intensely-heated air is now made to pass over the metal in a state of fusion, and the lead and copper becoming oxidated, are absorbed by the cupel, or skimmed off, and the gold is left behind. The lead is the great agent, for its oxide is easily fusible into a glassy substance, which sinks into the cupel, carrying the other impurities along with it; so that if the ore does not naturally contain much lead, a portion is added. We have described these processes only very generally: there are many delicate manipulations in the mode of conducting them, upon which success in the result greatly depends.

In our next section we shall proceed to describe the principal sources from which gold is derived. The 'Historical Inquiry into the Production and Consumption of the Precious Metals,' by William Jacob, Esq., may be consulted with advantage by those who are desirous of minute information; and we have ourselves relied upon it for many of the facts contained in the following sections.

Lead. — The appearance of this substance in its metallic state is undoubtedly familiar to every one. It is one of the most useful of mineral substances, and forms one of the most valuable products of the mines of Great Britain. Its specific gravity is considerable, being more than eleven times the weight of an equal bulk of water. It is malleable, and with ease may be reduced into very thin plates; but it is liable to crack under the hammer. It is so far ductile as to be capable of being drawn into wire $\frac{1}{120}$ part of an inch in thickness, but its tenacity is very low; for a wire of that diameter breaks with a weight a little exceeding eighteen pounds. As it possesses no elasticity, it is incapable of compression, and differs in that respect from all the other ductile metals, which diminish in volume, and, consequently, increase in density, under the hammer; but lead has the same specific gravity when it is simply melted as when it is beat or rolled out into plates. It is the least sonorous of all the metals. It is easily fusible, melting at 612°, or a heat less than three times that of boiling water; but not so easily as tin, which melts at the temperature of 442°. When first melted, or when cut, it has a brilliant lustre; but this shining surface, however, is soon tarnished by attracting oxygen and carbonic acid from the air: but this coating of carbonated oxide, once acquired, protects it from farther change. Water has no action upon it: and hence its usefulness for cisterns and pipes. When exposed to the continued action of a stream of hot air, it rapidly acquires oxygen, and is converted into a substance which is called "litharge."

Lead has been sometimes found in the pure, or native state; but very rarely, and always in small quantity. It is one of the metals which is found in the greatest variety of combinations: but there is only one kind of ore which is very abundant; the rest are chiefly known as objects of interest to the mineralogist; many of them afford very beautiful specimens for the cabinet. The common ore is a combination of eighty-six parts of lead and fourteen of sulphur, and is called usually by the name of *Galena*, or sulphuret of lead. It very often contains silver, and in sufficient quantity to pay the expense of a process for separating it. That of the north of England contains from 2 to 24 ounces of silver to the ton, and the average quantity is 11½ ounces. The galena

of the mine Huel Pool, in Cornwall, yielded 60 ounces; of Guarnock Mine, near Truro, 60 ounces; and a mine near Beeralstone, in Devonshire, yielded galena so rich as to give 135 ounces of silver to the ton. A great proprietor of lead mines in the north of England had a splendid service of plate made of the silver so separated from the lead ore.

In geological position, lead is most abundantly met with in the lower strata of the secondary sedimentary deposits, especially in the carboniferous limestone. It is found also in considerable quantity in the strata below these, in the grauwacke, clay-slate, mica-slate, and even in gneiss, which is the lowest of the stratified rocks. It is found also, but more rarely, in the unstratified rocks, both in granite and in trap; but in all the instances that have been mentioned, the granite and trap have always been associated with stratified rocks containing lead ore. It is occasionally found in the coal-measures, but not hitherto in any of the strata above the coal. Galena, next to pyrites, or sulphuret of iron, is the most common of the metallic ores, and it is found in almost every country of the globe; but there are large tracts without any deposits of it in sufficient abundance to be worked.

England produces annually nearly three times as much lead as all the other countries of Europe put together. The chief mines are in the north of England, in Derbyshire, North Wales, and Devonshire, on the borders of Cornwall. The great seat of the north of England mines is that high district around the mountain of Cross Fell, where the counties of Northumberland, Cumberland, Westmoreland, the North Riding of Yorkshire, and Durham, meet, as it were, in a central point, and from which they radiate. The mines first become of importance on Muggleswick Moor, on the borders of Northumberland and Durham, about twenty-seven miles from the east coast of Sunderland, and at Blanchland, on the river Derwent, a little to the west of Muggleswick; and they continue to the summit of Cross Fell. Aldstone Moor, in Cumberland, and Dufton, in Westmoreland, are important places in this district; and there are mines in Weardale, Teesdale, Allendale, and Askendale. Mr. Forster reckons that, in this part of England, there are no less than 175 lead mines, which either have been or are now worked. The prevailing rock is the carboniferous limestone,—that great deposit which lies immediately under the coal strata in most parts of England. It is associated with strata of sandstone and slate; and there are about twenty different beds of limestone which the miners distinguish by distinct names. The series of strata at Aldstone Moor, according to a section given by Mr. Winch, consists of about sixty alternations of slate, sandstone, and limestone, in 159 fathoms, or 954 feet. The whole are covered by the coarse sandstone commonly known by the name of "millstone grit." The above dimensions are only a part of the strata where they are bored through in sinking the well, or shaft of a mine; but if we include the whole deposit from the upper surface of the old red sandstone, on which the series rests, we obtain a total thickness of nearly 2800 feet. Beds of trap, one of which is particularly designated the "Whin Silt," a miner's term, are interposed between the strata in several places. The lead ore occurs in veins, which traverse the strata in various directions, and in many irregular ways, sometimes being very slender, at other times extending to great widths. They are usually of larger dimensions in the limestone than in the slate and sandstone: one vein, which is seventeen feet in a limestone stratum, contracts to three feet in the sandstone below; and they are always much richer in ore, even in proportion to their magnitude, in the limestone. That part of the series which is richest in lead does not exceed 300 feet. The mineral substances which accompany the ore, forming what is called the "vein-stone," are calcareous spar, fluor spar, quartz, and a few others of less frequent occurrence. The mines in this part of England have yielded, of late, on an average, about 25,000 tons of lead annually, which is more than one-half of the whole produce of Great Britain; and of that amount nearly a third is obtained from the mines belonging to Greenwich Hospital. In the year 1831, 28,000 tons were raised from the mines of Cumberland, Northumberland, and Durham.

The lead mines of Derbyshire are situated in the north-western part of the country, extending as far south as the neighborhood of Matlock. That district is almost wholly composed of the carboniferous limestone, which is surrounded on all sides by the millstone-grit that lies above it. The limestone is very much disturbed in its stratifications, and is intersected by dikes and beds of trap. There are limestones of various qualities and colors in the series, chiefly of a grey and fawn color, but sometimes quite black; and several of the beds being of a texture which receives a good polish, they are used as marbles for architectural and ornamental purposes. The limestone-beds contain numerous great caverns, which are often visited by travellers. The ore is galena; but it contains in general too little silver to repay the cost of

extracting it. The vein-stones that accompany the lead ore are usually calcareous spar and fluor; the latter being the substance which is so generally known by the name of "Derbyshire Spar,"—a beautiful mineral, and capable of forming handsome vases, and such like ornaments. This mineral is a compound of lime with a peculiar acid, which, from having been first found in it, was called "fluoric acid." Farey, in his 'Mineral Survey of Derbyshire,' enumerates no less than 280 mines, which had been, or were then (1811,) working.

Next in importance to the mines of the north of England, those in North Wales, in Flintshire, and in Denbighshire, are the most productive: a small quantity is raised in Shropshire, and in the neighborhood of Tavistock in Devonshire. Lead ore has been found in different places in the Isle of Man, and mines were worked there in the reign of Henry IV.; they were even in some activity as late as the early part of the last century, but they are now almost given up. It is found in the counties of Down and Wicklow in small quantities, sufficient, however, to be worth working. The lead mines of Scotland are more productive. The most important are those situated in the grauwacke, or slate-rocks, composing the range of hills which runs quite across the south of Scotland, from St. Abb's Head, north of Berwick, and in that part of it called Lead Hills and Warlock Head, on the borders of the counties of Lanark and Dumfries, north-east of Sanquhar. These mines were discovered in the year 1540, and have yielded large revenues to the proprietors ever since. The veins traverse the grauwacke rock from north to south, and very considerably in thickness, some of the principal ones being from four to ten feet in width. At one time, the Susannah vein exhibited a mass of solid ore no less than fourteen feet thick; this was probably a junction into one of several small veins. Some years ago, the mines of Lead Hills and Warlock Head together yielded about 2400 tons annually. Lead has been wrought at Tyndrum, in Argyleshire, where the ore is found in a bed of quartz, which is part of a series of strata of the primary rock, mica slate; and also at Strontian, in the same county, where the galena traverses gneiss, the oldest of the primary strata. The produce of the different lead mines in Scotland was at one time estimated to amount to 4800 tons, but it has, of late years, fallen off very considerably. Mr. Taylor, in his 'Records of Mining,' gives an account of the quantity of lead raised from the mines of Great Britain in the year 1828, which, he says, was the result of a careful inquiry among those best acquainted with the subject. It is as follows:

	Tons.
North of England Mines -	- 26,700
Derbyshire and Shropshire	- 4,800
Devonshire and Cornwall -	- 2,000
Flintshire and Denbighshire	- 12,000
Scotland - - - - -	- 1,000
Ireland, Isle of Man, &c.	- 500
	47,000

Five years prior to this, the whole amount was only 36,000.

Method of obtaining the Metal from the Ore.—The ore, after having been properly broken, and separated as much as possible from the vein-stones, is roasted in a furnace, with a small quantity of coal, in order to expel the sulphur, and any other volatile matter which it may contain. After undergoing this process, it is taken to a blast furnace, of a peculiar construction, called an "ore-hearth," where, by a powerful heat, the ore is melted, and the metal separated from the dross, or slag, which swims on the surface; the mass being frequently stirred, to facilitate the separation, for a period of from twelve to fifteen hours. There are various manipulations during the process, and these, together with a supply of fuel and of lime (which is added to facilitate the reduction), are modified according to the nature of the ore, and require much skill and tact on the part of the workman. The slags, still containing a portion of lead, are subjected to another process of smelting with coke in another furnace. In all these operations a considerable quantity of the ore is volatilized, and condenses in the chimneys of the furnace: this, which is called "smelters' fume," is collected from time to time, and the lead is extracted from it.

The quantity of silver contained in the greater part of the lead ore raised in the north of England is sufficient to render its extraction profitable. The separation of lead and silver is effected by the different degrees of attraction which the two metals have for oxygen, the silver remaining unaltered, when exposed to the air of the atmosphere at a high temperature; whereas lead, under the same circumstances, becomes rapidly converted to a protoxide;—that is, becomes a new substance, composed of lead and a minimum quantity of oxygen, and which is commonly known by the name of "litharge." The lead to be refined is placed in a furnace so constructed as to admit of the ready separation of the litharge as it is formed; it is melted and farther heated till it becomes of a bright red, and then the blast of air is made to

pass over it. This not only supplies the oxygen, but is sufficiently strong to sweep away the oxide as it is formed, by which means a fresh surface of the melted lead is exposed: more lead is supplied, from time to time, as the operation proceeds, and, at the end of the process, a cake of silver is found at the bottom of the furnace. The lead is recovered from the litharge, by a very simple process, which consists in mixing it with coal, and exposing it to a strong heat: the carbon of the coal has a stronger attraction for oxygen than lead has, and therefore separates it from the litharge, leaving the pure metal, which is run out into moulds to form the pigs, or bars, in which shape it is brought to market. This process of extracting the silver from the lead was not introduced in the north of England mines till the reign of William and Mary.

The working of lead mines in Great Britain dates from a remote period. The mines in Derbyshire, it is supposed, were wrought in the time of the Romans; the proofs of which are derived from blocks or bars of lead which have been found with Roman inscriptions upon them. A bar of this kind was discovered on Cromford Moor in the year 1777, and the interpretation of the inscription which has been given is the following: "The Sixth Legion inscribe this in memory of the Emperor Adrian." Another bar was met with near Matlock in 1783, the inscription of which has been translated as follows: "The property of Lucius Aruconius Verecundus, merchant of London." The Saxons and Danes, it is supposed, were also engaged in working the mines of Derbyshire, from the designation of the Odin Mine, at Castleton, which it is conjectured was so called from the name of the northern deity.

Uses of Lead.—Besides the various purposes to which it is applied in its pure state, lead is employed in many different ways in combination with other substances. The sulphuret of lead—that is, the common ore, galena—is made use of, without any previous preparation, as a glazing for coarse pottery. The protoxide, or litharge, enters largely into the composition of flint-glass, which it renders more fusible, transparent, and uniform. Combined with another proportion of oxygen, it forms *Red Lead*, which is also used in the manufacture of flint-glass, and as a paint. *White Lead*, which is so extensively used as a paint, is a combination of the metal with oxygen and carbonic acid. *Sugar of Lead*, which is used very largely in several manufactures, particularly in calico printing, and also in medicine as an external application, is a compound of lead and acetous acid, or vinegar. It is so called from having a remarkably sweet taste: it is well known, as well as most of the combinations of lead, to be a deadly poison.

Of the 45,000 tons of lead which may be estimated as the average produce of the mines of the United Kingdom, about one-third is exported. In the year ending January 5, 1833, the exports were as follows:

	Tons.
In pigs, and rolled, and shot,	12,181
Litharge	433
White Lead	652
Red Lead	396
Lead Ore	236
Total	13,898

The countries to which that quantity was exported were,—

	Tons.
United States of America	4,896
East Indies and China	2,980
Russia and Sweden	1,951
Germany	634
Brazil	526
West Indies	514
British North America	480
The Netherlands	456
Cape of Good Hope and Africa	435
New South Wales	223
Italy and the Levant	226
Spain and Portugal	226
Other places in lesser quantities	351
Total	13,898

No species of property, perhaps, has undergone so great a deterioration in so short a time as that of lead mines. In the year 1809, the market-price of lead in bars was £31 3s. per ton; and, according to the tables given by Mr. Macculloch in his 'Commercial Dictionary,' the average price for the ten years ending 1810 was £27 14s. 6d. It rose to £31 in the year 1814, when speculations at the close of the war raised the value of many of our native products; but the average of the ten years ending 1820 was £23 6s. 6d. A sudden fall took place five years afterwards, for in 1825 the price was £25 6s., and the following year it fell to £19; and it kept falling till 1832, when it was down to £13 10s. From that extreme depression it has partially recovered, the present market price being about £18 per ton. This extraordinary fall was occasioned by a sudden increase of supply from the lead mines of Spain. These mines are situated in Andalusia, partly in a range of mountains to the north of Jaen, near Linares, but chiefly in another range which lies between Jaen and the city of Granada, and on the southern slope of them. We know little about

these mines beyond their locality, for the geology of Spain is as yet very imperfectly understood. Bowles, who wrote in the year 1776, describes the mines to the north of Jaen to have been worked by the Moors, and says that the mountains are pierced by shafts in all directions; that there are two great veins which pass through granitic rock, which vary considerably in richness; and that at one time one of the mines produced in a year more than all the lead mines of Saxony together had done in twelve years. But it is the mines in the mountains of Granada from which the recent great supply has been obtained. The ore lies near the surface, and is therefore obtained without much exercise of skill, or expense of labor and machinery. Mr. Witham says, that "the metalliferous limestone of the south of Spain is so rich in galena as to furnish, even in the present imperfect state of mining in that country, about 20,000 tons of lead annually. France has some lead mines in Britany, Languedoc, Alsace, and other parts of her territory, but imports the greater part of her consumption, and chiefly from Spain; England having sent only 70 tons to France out of the 13,898 exported in 1832. There are many lead mines in Saxony, Bohemia, Silesia, and other parts of Germany. Although the exports to the United States from this country are so considerable, they are not without ores of that metal in their own country. The mines are situated in Pennsylvania, Massachusetts, and on the Fever and Missouri river in the Western States; the richest being in the latter country. The total produce in 1829 exceeded 6000 tons.

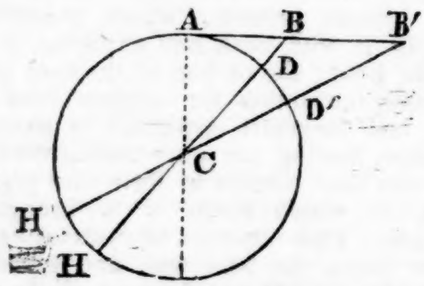
[For the Mechanics' Magazine.]

LEVELLING.

It is not my object, in preparing this article, to give the whole system of levelling, in all its branches; but merely to give an idea of its principles, enough to enable the reader to take the level of any short distance without the trouble and expense of calling the assistance of professional men; but before entering directly upon the subject, it is necessary to give a general denomination.

Two or more points are said to be on a level when they are equally distant from the centre of the earth,* or from the surface of a tranquil fluid, supposed to be situated immediately above or below them. A level surface, therefore, is one that is every where perpendicular to a plumb-line, or the radius of the earth considered as a sphere. This is called a *true level*, while a strait line or plane, that is perpendicular to the radius of the sphere or plumb-line only at one point, is denominated an *apparent level*. Thus, AB represents an apparent level, AD a true level, and BD the deviation of one from the other, or the *difference of level* of the points A, B, referred to a tangent at A.

Fig. 1.



Knowing the tangent AB, we readily find BD by the proportion, BH : AB : : AB : BD; which gives $BD = \frac{AB^2}{BH} = \frac{AB^2}{2CD + BD}$.

But, as BD is always small in comparison with 2CD, the diameter of the earth, it may be neglected in the second member of the above equation;* and, in most cases, for the same reason, AD may be considered as equal to AB; whence, $BD = \frac{AD^2}{2CD}$.

In like manner, for another distance AD′, we shall have, $B'D' = \frac{AD'^2}{2CD}$; and $BD : B'D' :: \frac{AD^2}{2CD} : \frac{AD'^2}{2CD} :: AD^2 : AD'^2$.

That is, *the difference of level for different distances is as the square of the distance.*

The distance AD being supposed, for example, = one statute mile, or 5280 feet, and 2CD, the diameter of the earth, = 7912 miles, or 7912 × 5280 feet, we have

$$BD = \frac{(5280)^2}{7912 \times 5280},$$

and by logarithms,

5280	- - 2 log.		7.44521
7912	- - log.	3.89829	
5280	- - log.	3.72263	
			7.62092
			—1.82434

0.6073
12

BD = 8.0076 inches.

Thus, the difference between the apparent and true level, answering to a distance of one mile, is 8 inches.

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* The small errors committed by supposing the earth a sphere instead of a spheroid, are safely neglected in the common operations of levelling.

* If it were necessary, we might obtain the difference of level without neglecting BD. Then from the above equation we obtain $BD^2 + 2CD \times BD = AB^2$; or, calling BD x, CD a, and AB b, $x^2 + 2ax = b^2$, and $x = -a + \sqrt{b^2 + a^2}$.

For any other distance, as $2\frac{1}{2}$ miles for instance, instead of repeating the above process, we can use the proportion,

$$1^2 : 2.5^2 : 8 \text{ inches} : 50 \text{ inches.}^*$$

Fig. 2.

We will now proceed direct to the subject.

F is the formation, and E the place assigned to carry the water to; the distance we will suppose to be half a mile.

Note. To perform this business, you must be provided with two staves graduated in inches and tenths, which may be from 4 to 6 feet long; and also a water level, which may be made easily at any joiner's shop; the level may be of any convenient length, dug out hollowing, so as to hold water; with sights at the top to make the observations through; having provided these, go to the fountain with two assistants, and observe the following rule:

Rule. Order the first assistant to the fountain with one staff placed perpendicular; and the second assistant to any convenient place, as at A, with his staff perpendicular; then place the water level in the middle, as at W; then looking through the sights, order the first assistant to move a piece of white paper up and down the staff till you can see it through the sights; then order him to note the distance it rests from the ground; and, going to the other end of the level, order the second assistant to do the same; after this is done, order the first to take the place of the second, and the second to take a new stand at B; place the water level, and proceed as before, marking down the distance the white paper rests as before, and then take another stand, and proceed till the second arrives at the destined place, at E; then have the assistants cast up their notes, and as much as the second assistant's notes exceed the first, so much does the ground descend; and as much as the second assistant's notes are less than the first, so much does the ground rise. In the above example, the assistants' notes are as follows:

1st assistant's notes—

1st station,	- - - -	0 ft.	7 in.
2d "	- - - -	1	0
3d "	- - - -	0	2
4th "	- - - -	1	2
5th "	- - - -	0	4
		3	3

2d assistant's notes—

1st station,	- - -	1 ft.	0 in.
2d "	- - - -	0	6
3d "	- - - -	1	6
4th "	- - - -	0	2
5th "	- - - -	0	7
		3	9

The second assistant's notes exceed the first by 6 inches; of course the ground is 6 inches lower at E.

Thus, by the rule—$1^2 : 5^2 :: 8 :: 16$, about two inches for the allowance of the earth's curvature—that is, allowing the distance to be .5 or half a mile, as stated above.

S. A.

Mistakes in Education.—The following extract from President Vethake's Address at his recent inauguration as President of the Washington College, Va., points to a common evil of popular education. The author is himself a sound and practical instructor, of much experience, and speaks advisedly.

"Another reason why young men in our colleges are tempted to neglect the general cultivation of their minds, and to devote their whole study to the storing of their memories with the contents of the text-books put into their hands, is, that their comparative scholarship is very apt to be estimated by their instructors, not so much by the *nature* of the question which they are able to answer correctly, and by the amount of thinking and originality displayed, as by the promptitude and fluency with which they can repeat what they have servilely learned. I have been told by more individuals than one, and by graduates of more institutions than one, that on discovering, while at college, the fact to be as I have just stated, and being anxious that the best account of them should go to their friends from their professors, they at once resolved to subject themselves to the

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* The difference of level for a mile being in feet $\frac{5280\times5280}{7912\times5280}$, or $\frac{5280}{7912}$; that is, $\frac{2}{3}$ very nearly, and the difference of level for any other distance being as the square of the distance, we have the following convenient rule for finding the difference of level, namely, *take two thirds of the square of the distance in miles for the difference of level in feet nearly. Thus, in the above* example, $\frac{2}{3}(2{\cdot}5)^2$, or $\frac{2}{3}\,6\frac{1}{2} = 4\frac{1}{3}$ feet, or 52 inches.

drudgery, and that by so doing, they did not fail to secure the object they had in view. The persons of whom I spake were young men of talent, as well as ambitious of immediate distinction. Had their minds at the time been sufficiently matured to have adequately appreciated the uselessness and the folly of this method of study, without at the same time being matured enough to adopt, of their own suggestion, a more efficient and rational method, and had they been less influenced by present rewards, without as yet aspiring to the more substantial rewards of a future reputation among men, or without the loftier stimulant of duty, they might have become, like others, among their fellow students, altogether negligent of their improvement, and perhaps have contracted the most ruinous habits. It is to the system of education upon which I am animadverting, together with the mistakes made by the members of a college faculty, in deciding on the comparative scholarship of the students—which mistakes the latter are competent to judge of with a good deal of accuracy — the anomaly, so often remarked, of a young man's relative *standing* while in college being often but so little indicative of his future standing in the world, is to be ascribed; and the explanation is likewise manifest why some individuals of peculiar energy of character, after wasting their time in almost complete idleness while at college, astonish their friends nevertheless by the intellectual exertion of which they show themselves to be capable when an adequate motive is presented for exerting their energies. This resolves the mystery, too, why so many *self-taught* men have, in despite of the disadvantages under which they labored, surpassed the graduates of colleges in usefulness and reputation; every acquisition made by a self-taught man, in consequence of the very difficulty of making it, being accompanied by a contemporary sharpening of his intellect, which the passive recipient of another's knowledge never experiences."

"So was Franklin,"—O you're a 'prentice," said a little boy the other day, tauntingly, to his companion. The addressed turned proudly around, and while the fire of injured pride and the look of pity were strangely blended in his countenance, coolly answered, "*So was Franklin.*"

The motto of our infantile philosopher contains too much to be forgotten — and should be engraved on the minds of all. What can better cheer a man in a humble calling, than the reflection that the greatest and best of earth—the greatest statesmen—the brightest philosophers, and the proudest warriors—have once graced the same profession?

Look at Cincinnatus! At the call of his country he laid aside the plough and seized the sword. But after wielding it with entire success — when his country was no longer endangered, and public affairs needed not his longer stay — he "beat his sword into a plough-share," and returned with honest delight to his little farm.

Look at Washington! What was his course of life? He was first a farmer; next a commander-in-chief of the host of freedom, fighting for the liberation of his country from the thralls of despotic oppression; next, called to the highest seat of government, by his ransomed brethren, a President of the largest republic on earth; and lastly, a farmer again.

Look at Franklin! He who

"With the thunders talked, as with a friend,
And waved his garland of the lightning's wing,
In sportive twist."

What was he? a printer! once a menial in a printing office! Poverty stared him in the face—but her blank, hollow look could not daunt him. He struggled through a harder current than most are called to encounter; but he did not yield. He passed manfully onward, bravely buffeting misfortune's billows, and gained the desired haven!

What was the famous Ben Jonson? He was first a brick-layer or mason! What was he in after years? 'Tis needless to answer.

But shall we still go on, and call up in proud array all the mighty host of worthies that have lived and died, who were cradled in the lap of penury, and received their first lesson in the school of affliction? Nay, we have cited instances enough already; more than enough to prove the point in question; namely, that there is no profession, however low in the opinion of the world, but has been honored with earth's greatest and her worthiest.

Young man! Does the iron hand of misfortune press hard upon you, and disappointment well nigh sink your despairing soul? Have courage! Mighty ones have been your predecessors — and have withstood the current of opposition that threatened to overwhelm their fragile bark!

Do you despise your honorable station, and repine that you are not placed in some nobler sphere? Murmur not against the dispensations of an all-wise Creator! Remember that wealth is no criterion of moral rectitude, or intellectual worth; that riches dishonestly gained are a lasting curse; that virtue and uprightness work out a rich reward; and that

"An honest man's the noblest work of God."

And when dark disappointment comes, don't wither at her stare; but press forward, and the prize is yours! It was thus with Franklin; it can be thus with you. 'Tis well worth contending for, and success may attend you; and the "stars" will be brighter than the "stripes."—[Utica Record of Genius.]

The annexed account of the elevation of *Menschikoff* from the station of a pastry-cook's waiter, to be first and confidential minister under three monarchs, is a striking illustration of the truth of the maxim, that, "every man may be the architect of his own fortune." It shows conclusively that a man of talents, industry, and prudence, may rise, notwithstanding the obstacles with which he may find himself surrounded, to the most elevated stations in society; and it also shows that, with all the advantages of the most elevated stations, without honesty and virtue, he is liable, and not only *liable*, but almost sure, to be precipitated from his elevation, to the depths of degradation and misery. How true, then, is that maxim which should be familiar to every *boy*, as well as man,

"Honor and shame from no condition rise;
Act well your part, there all the honor lies."

Alexander Menschikoff, the son of a peasant, born near Moscow, in 1674, was employed by a pastry-cook to sell pastry in the streets of Moscow. Different accounts are given of the first cause of his rise. According to some statements, he overheard the project of a conspiracy by the Strelitz, and communicated it to the czar; other accounts represent him as having attracted the notice of Lefort (q. v.), who took him into his service, and, discerning his great powers, determined to educate him for public affairs. Lefort took the young Menschikoff with him on the great embassy in 1697, pointed out to him whatever was worthy of his attention, and instructed him in military affairs, and in the maxims of politics and government. On the death of Lefort, Menschikoff succeeded him in the favor of the czar, who placed such entire confidence in him, that he undertook nothing without his advice; yet his passion for money was the cause of many abuses, and he was three times subjected to a severe examination, and was once also condemned to a fine. The emperor punished him for smaller offences on the spot; but much of his selfishness and faithlessness was unknown to his sovereign. He was much indebted, for support, to the empress Catherine. He became first minister and general field-marshal, baron and prince of the German empire, and received orders from the courts of Copenhagen, Dresden, and Berlin. Peter also conferred on him the title of duke of Ingria. On the death of Peter, it was chiefly through the influence of Menschikoff that Catherine was raised to the throne, and that affairs were conducted during her reign. (See *Catherine I.*) When Peter II. succeeded her on the throne, Menschikoff grasped, with a bold and sure hand, the reins of government. In 1727, when his power was raised to the highest pitch, he was suddenly hurled from his elevation. Having embezzled a sum of money which the emperor had intended for his sister, he was condemned to perpetual exile in Siberia, and his immense estate was confiscated. He passed the rest of his life at Berezov, where he lived in such a frugal way, that, out of a daily allowance of ten roubles, he saved enough to erect a small wooden church, on which he himself worked as a carpenter. He sunk into a deep melancholy, said nothing to any one, and died in 1729. Menschikoff was selfish, avaricious, and ambitious, implacable, and cruel, but gracious, courageous, well informed, capable of large views and plans, and persevering in the execution of them. His services in the promotion of civilization, commerce, the arts and sciences, and in the establishment of Russian respectability abroad, have been productive of permanent effects.

We have been favored with the following answer to a request made in No. 1 of the Apprentice's Companion, in relation to the bequest of Dr. Franklin, to the town of Boston, for the benefit of young mechanics.

To the Editor of the Apprentice's Companion:

Sir,—In the first number of the Companion you republished that part of Doctor Franklin's will by which he bequeathed £1000 sterling to the inhabitants of the city (then town) of Boston, and the same sum to the inhabitants of the city of Philadelphia, for the purpose of establishing a fund in each city for the benefit of young mechanics, to assist them by loans "in setting up their business." In remarking upon which, you said, "Of the success of this noble offer we are entirely uninformed, and would request some one familiar with the subject to communicate the facts." As respects the bequest to the inhabitants of Boston, the facts are these: The town ac-

cepted the donation, and the money was received, and by the municipal authority appropriated conformably to the provisions of the will. The fund, however, has not accumulated *to the extent* of the benevolent donor's calculation. Whether this deficiency is the effect of losses, or a lack of borrowers, or of both, I am not informed. Probably it is the effect of these conjointly.

The value of the fund on the 30th day of April, 1834, was stated by the city auditor, in his annual report, to be $20,551 91; but it would have been $36,285 16 had it drawn a compound interest of 5 per cent. during the *whole* time of its subsistence, and had there been no losses. For, as Dr. Franklin died on the 17th day of April, 1790, and the project was to go into operation within one year after his death, it had then been in operation 43 years and 13 days, in which time it would have increased to a little more than eight times the original sum. It is manifest, however, from the above-mentioned report, that it had not increased at the rate of five per cent. from year to year, during the *whole* time, for during the year *preceding* the 30th of April, 1834, the increase is stated to be only four and a half per cent. The number of persons who have already received assistance from this benevolence, is two hundred and fifty-three.

It will be seen by the results above stated, that the benevolent wishes of Dr. Franklin in regard to this donation have hitherto been, to a considerable extent, realized, and that there is now a valuable fund, which is constantly increasing, under the supervision and management of the city government, appropriated to the prudent use of a deserving class of citizens, which fund, should the future increase be only in the proportion that it has hitherto been, must amount to a vast sum in the course of two centuries.

It is to be hoped that some of your Philadelphia correspondents will gratify the public with a statement of the results of the bequest to that city.

Yours respectfully,

D. H.

We thank D. H. for his prompt reply, and again repeat our request that some one familiar with the condition of the fund in Philadelphia, will communicate the facts for the information of all who admire the liberality, and revere the memory, of the donor.—[Ed. A. C.]

Digestive Apparatus of Animals. — There are some families of fishes, as the mullets of Africa, possessing the gizzards of fowls—digestion in the stomach being performed apparently by mechanical means, —attrition, through the direct agency of a collection of gravel. A question arises here, whether they are partial to animal food, a distinguishing trait in the physical characters of fishes. Within about thirty years it has been very satisfactorily ascertained that the great basking shark, once viewed as a terrific, voracious monster, prowling through the ocean in search of dead men's bones, is a quiet, unoffending, cowardly compilation of flesh, perfectly content to feed on floating sea weed. For the purpose of extracting the nutrition, and also for an economical expenditure of vital energy, the stomach is an immensely capacious pouch, into which a cart-load may be stowed away for future want. Below this, the intestinal canal is prolonged, as in the herbivarous quadrupeds, nearly twice the length of the body: but as a still further mechanical security, a continuous valve or shelf juts out from the inner circumference, past the centre, running the entire length, to prevent the too rapid descent of the food. Thus, being exposed to the action of such a prodigious absorbing surface, not a particle is lost till all its substance capable of being converted into blood has been conveyed away by the lacteals. Some birds are organized for digesting the kinds of food peculiar to bears and wolves; and others gorge living prey, much after the manner of the ophidians. Into whatever system of animal organization we cast an inquiring eye, we are confounded by the diversity of mechanical contrivances for sustaining the active principle of life.—[Scientific Tracts.]

[From the London United Service Journal.]

Lang's Patent Cordage.—The manufacture of cordage is an object of paramount importance to a maritime country, although the consumption of hempen rope has lately been more successfully invaded by the use of iron chains, than ever it was by the various attempts made with hides, wool, grass, and other materials. We have, therefore, perused the pamphlet circulated by Macnab and Company, of Greenock, with considerable interest, and can recommend it to the notice of our readers as a clear exposition of a most useful invention.*

The art of rope making had been a sort of *rule-of-thumb* process till our own

* Exposition of the Principles of Mr. J. Lang's Invention for spinning Hemp into Rope Yarns by Machinery, and its effect on the strength and durability of Cordage.

days: and no very serious attempts were made to correct the obvious defect of different tension on the component parts of the twisted strand. The science of Huddart, however, and the practice of Chapman, were brought to bear upon this important point, and introduced the principle, by which an increase in the strength of the cordage was effected by simply so constructing the rope as that every yarn is made to bear its own proportion of the strain. And it is by carrying this principle to its utmost that Mr. Lang has been enabled to effect an additional increase of strength, and, consequently, of durability to the rope. This has been accomplished by means of a machine affording a more just arrangement, regular twisting, and equal bearing of the fibrous substances which are employed in the composition of the yarns, than any heretofore used.

The utility of such an improvement, upon what has been aptly termed "the very sinews and muscles of a ship," will be manifest, by recurring to the well known question of M. Reaumur, as to the strength of ropes made of twisted strands, compared with those composed of parallel parts, selvage fashion; in other words, whether the strength of a cord was greater or less than the sum of the strength of its threads. After gathering all that could be urged for and against twisting, the philosopher had recourse to experiment to decide between them. The result was, that contrary to all expectation, the twisting was found to diminish the strength of the rope; whence it was readily inferred that it diminishes it the more as the rope is the thicker. For, inasmuch as the twisting diminishes, the more twisting the more diminution, according to the system in use previous to Captain Huddart's making the yarns all bear an equal proportion of the strain. Successive improvements caused the strands to be laid more uniformly in the rope, and every strand to receive an equal degree of twist, by which the rope was rendered stronger, and of a general degree of strength throughout.

By Mr. Lang's invention, all the former principles are carried into still greater effect; and by it the regular spinning of yarns, which had hitherto been prepared in a tedious and clumsy manner by hand labor, is accomplished. But a still more important object has been achieved. By the same plan, the hemp, to whatever purpose applied, being drawn over a succession of gills, or small hackles, is dressed in the highest degree: hence the fibrous substances of the hemp are regularly split and subdivided; they are also multiplied to such an extent, that their number in a patent spun yarn will be found more than double the quantity of those which compose a hand-spun yarn of equal girth, which must increase its strength in no inconsiderable degree. Again, while the fibres are thus greatly multiplied, they are also completely elongated and laid straight, so as to admit of being regularly twisted, and each fibre being stretched its full length, and laid parallel to others in the yarn, they are all made to bear at the same time, and equally, in the strain; thus every fibre of the hemp is called into action, and contributes its own proportion of strength to the fabric. Nor is this all. By hand labor the hemp can only be spun from the bight, or middle; and, therefore, only one-half of the length of its fibre is extended in the yarn; consequently, some qualities of hemp have hitherto been considered inferior, because, on account of the shortness of their fibre, they would not admit of being doubled. Now, Mr. Lang's plan has this additional advantage, that the hemp is spun by the end of the fibre, and thus, by having its whole length extended in the yarn, those qualities of hemp hitherto considered inferior, because shorter, may be applied with equal safety and advantage, and do in reality produce cordage as strong and as durable as the others. Indeed, the average length of what is termed staple hemp, when spun from the bight, may be estimated at about twenty-seven inches; whereas the average of the pass, or short hemp, by having its whole length extended, is about thirty-five or thirty-six inches; if, therefore, length of fibre is essential to the tenacity of the yarns, the new system has the decided advantage.

Such are the principles of Mr. Lang's invention; and as it produces a superior article, and at a cheaper rate than the competitors in the trade can supply it, it is evidently entitled to patronage. We regret, however, to find that the proprie-

tors have to complain of detraction and wilful misrepresentation; but we think the statements made by them are fully substantiated, both by actual experiment, and by the testimony of many unimpeachable individuals who have used the patent cordage. The question, of course, turns upon the two essential properties of ropes, which are strength and durability. To ascertain the former, reference has been made to immediate proof by experiment; and the tables which Macnab and Company have inserted in their exposition of the comparative trials under different circumstances show a triumphant balance in favor of the patent spun hemp. In forming a judgment of the other quality, a considerable time must necessarily elapse before all the various contingencies of climate and treatment can be examined. At the same time, it will be admitted, that the strongest cordage must, in the nature of things, be the more lasting. The tear and wear of a rope are properties absolutely inseparable; its strength must depend on the soundness of its material, and on its construction; and in proportion as these effect its strength, so must they also its durability.

These are grounds upon which Macnab and Company vindicate the patent cordage; and we think the impartial seaman, who peruses their pamplet, will rise well satisfied with their conclusions.

[For the Mechanics' Magazine.]

MEASURING DISTANCES.

1st. Wishing to know the distance from A to B, (fig. 1,) place a picket at B, and another at C, at a few fathoms distant, making ABC a right angle, and divide B C into 4, 5, or any number of equal parts; make another similar at C, in a direction from the object, and walk along the line CD till you bring yourself in a line with the object A, and any of the divisions, (say *o*,) of the line BC; then C *o* : CD : : B *o* : BA.

Fig. 1.

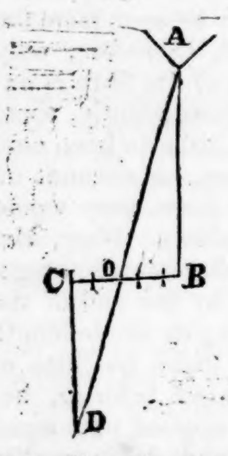
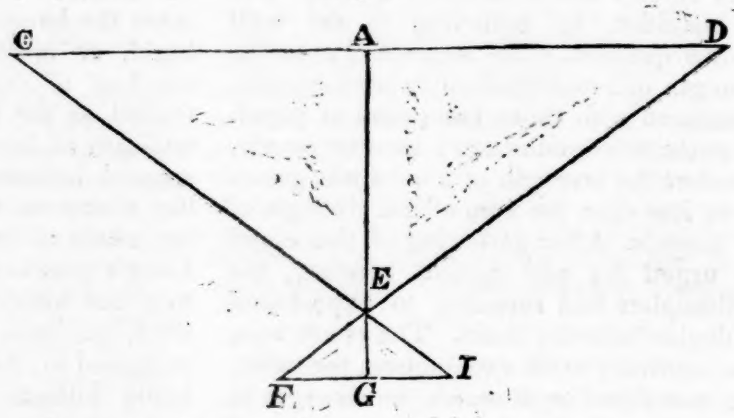


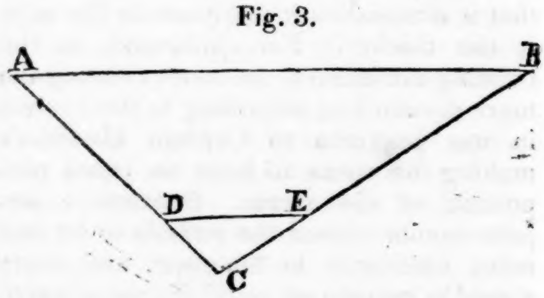
Fig. 2.



2d. To gain the distance between C and D, (fig. 2,) from any point A, taken in the line CD, erect the perpendicular AE, on which set off from A to E 1 or 200 feet, more or less, according to the distance between the points C and D; set off from E to G in the prolongation AE, $\frac{1}{3}$ or $\frac{1}{10}$ of AE; at G raise the perpendicular GF, and produce it towards T; plant pickets at E and G, then move with another, on GF, till it comes in a line with E and D; and on the prolongation of the perpendicular FG, place another picket at I, in a line with E and C; measure FI, and it will be as GE : AE : : FI : CD.

3d. To gain the inaccessible length AB, (fig. 3,) plant a picket at C, from whence both points may be seen; find the lengths CA and CB, by the method first given, (No. 1,) make CE $\frac{1}{4}$, or any part of CB, and make CD bear the same proportion to CA, measure DE, and it will be as CD : DE : : CA : AB.

Fig. 3.



NOTE. Nearly after the same manner may be ascertained the distance from A to B, (fig. 3,) when the point B is accessible; having measured the line CB, and made the angle CED equal to CBA, it will then stand thus: as CE : DE : : CB : BA.

S. A.